DOCUMENT RESUME

ED 054 565 EC 033 198

TITLE Programmed Learning for the Deaf Student. Symposium on Research and Utilization of Educational Media for Teaching the Deaf (Lincoln, Nebraska, March 22-24, 1971).

INSTITUTION Midwest Regional Media Center for the Deaf, Lincoln, Nebr.; New Mexico State Univ., Las Cruces. Southwest Regional Media Center for the Deaf.

SPONS AGENCY Bureau of Education for the Handicapped (DHEW/OE), Washington, D.C.

PUB DATE 71

NOTE 263p.

EDRS PRICE MF-$0.65 HC-$9.87

DESCRIPTORS *Aurally Handicapped; *Computer Assisted Instruction; Conference Reports; Educational Technology; *Exceptional Child Education; *Programed Instruction; Teaching Machines

ABSTRACT

The document consists of keynote speeches and discussion papers from the 1971 Symposium on Research and Utilization of Educational Media for Teaching the Deaf, which had as its general theme programed instruction (PI) for the deaf. The 14 papers cover the impact of PI at the Southwest Regional Media Center for the Deaf, evaluation of PI materials, the role of computer assisted instruction at the National Technical Institute for the Deaf, the relationship of economic factors to education and employment of the deaf, modification of automated instruction to financially allow its adoption, and PI in the curriculum at the Oregon State School for the Deaf in Salem, the Southwest School for the deaf (Lawndale, California), and Callier Hearing and Speech Center in Dallas. Also discussed are new directions and a new affective dimension in PI, methods for teaching communication skills, PI for young deaf children, research with the strands program in elementary mathematics in a computer-based laboratory for learning at Stanford, a graduate course in educational technology, and a PI course in electronics assembly. A discussion summary and the symposium program are included. (KW)

Robert E. Stepp, Ph.D., Director of the Midwest Regional Media Center for the Deaf, is Professor of Educational Administration, Teachers College, University of Nebraska. Dr. Stepp was Director of the University Bureau of Audiovisual Administration for 13 years and Assistant Director of the Extension Division for three years. Dr. Stepp has an A.B. degree from Central College (Missouri), an M.A. from the State University of Iowa and his Ph.D. was granted by the University of Nebraska.

Dr. Stepp is best known for his research in utilization of 8mm sound films to teach speechreading to deaf children. This "Feasibility Study to investigate the Instrumentation, Establishment, and Operation of a Learning Laboratory for Hard of Hearing Children" was done as a Title VII Project through the U.S. Office of Education.

Dr. Stepp has been active in both state and national audiovisual organizations. He has been a member of the Board of Directors of the Department of Audiovisual Instruction, N.E.A., a member of its Executive Committee and on the Editorial Board of Audiovisual Instruction. As an author, speaker, consultant and media specialist, Dr. Stepp's list of involvements in education of the deaf is endless.

The seventh annual Symposium on Research and Utilization of Educational Media for Teaching the Deaf was held at the Nebraska Center for Continuing Education, University of Nebraska, Lincoln, Nebraska, March 22-24, 1971. The national conference was sponsored by the Department of Educational Administration, Teachers College, University of Nebraska, and Media Services and Captioned Films, U. S. Office of Education, Department of Health, Education and Welfare. The general theme this year was "Programmed Learning for the Deaf Student."

This topic reflects a continuation of our concern that the deaf student must become an independent learner. Each symposium for the last seven years has stressed the importance of designing special programs for this purpose. The ultimate goal is to develop individually prescribed instruction.

The Foreword to the 1969 Symposium Report described this intent. "Educators need to make a definitive distinction between independent study and individualized instruction. Any program that the student studies by himself is independent study, even though every student in his class proceeds through the same identical sequence. This is not individualized instruction. Individualized instruction, on the other hand, may require group actions and activities. Truly individualized instruction means that each child is proceeding on his own learning continuum as designed and prescribed for him by his teacher-mentor who not only selects the content to be studied, but also the method, the mode, the manner and the conditions under which this learning experience is to take place. Each program should be distinct and planned to capitalize on the student's capabilities, utilizing these strengths into independent pursuits, rather than developing teacher dominated programs which stress weakness and approach the child through his disability."

Programmed Instruction is a form of independent study that offers valuable opportunities to the deaf student. The great surge of P.I. in the education field occurred in the 1950's. At that time there was an indication that this educational effort would be associated with new devices called teaching machines. As the years passed, fewer programs depended on these devices and more programs were published in a printed paper format. Research studies found no significant difference between the use of a programmed text or booklet and the use of the program with teaching machines.

Programmed Learning materials, by design, must have a logical order and sequence. The learning steps or "bits" must be small enough for the student to proceed on his own without failure and at the same time be large enough for the student to be motivated. Initial application of P. I. with deaf students was not too successful because the reading vocabulary used in commercial programmed material was too difficult. Experimental programs, simplifying the language structure and vocabulary, were designed to alleviate this problem. The most important result was the discovery that programmed learning provides another method of teaching the deaf and gives the teacher an option in selecting her instructional strategy. With P. I. the student can proceed at his own pace and be provided with confirmation indicators as to his success.

Probably the greatest contribution from P.I. to the whole field of education is the logic of its principles.

(1) Design or select P.I. materials for the needs of the learner

(2) Teach the student in small, prescribed increments

(3) Allow student to set his own pace

(4) Provide immediate confirmation

(5) Provide for reinforcement and review.

The handicapped student has need for similar logic in his educational program. There is no question but what the deaf student can profit from programmed learning. The question is "Can the educators, who teach the deaf, design the programs to educate the deaf"? This is the challenge.

Three keynote addresses were presented this year by Dr. Edgar L. Lowell, Administrator of the John Tracy Clinic; Mr. Peter Pipe, Senior Associate of Pipe and Associates; and Dr. Patrick Suppes, Institute for Mathematical Studies in the Social Sciences at Stanford University.

Discussion papers were prepared and distributed in advance of the Symposium by:

Hubert D. Summers, Ramon F. Rodriguez and Robert Edwards of the Southwest Regional Media Center for the Deaf;

Waunita L. Garner and Charles E. Zerrip, Jr. of Project LIFE;

Dr. O. Dennis Barnes and Arlene Finkelstein of the National Technical Institute for the Deaf;

Dr. Edgar L. Lowell, Administrator, John Tracy Clinic;

James E. McCarr, Teacher-Language Co-ordinator, Oregon State School for the Deaf;

Dr. Harry Murphy, Principal, Southwest School for the Deaf;

Elaine Costello, Instructional Programmer, Callier Hearing and Speech Center;

Helen Ross Sewell, Programmer, Texas School for the Deaf;

Joan Tellam, Teacher, Arizona School for the Deaf;

Dr. Donald Torr, Director--Office of Educational Technology, Gallaudet College;

Dr. Leo E. Persselin, Dubnoff School for Educational Therapy.

During the Symposium the speakers expanded on their papers, gave presentations, and delved into additional information on these topics.

Our appreciation and thanks are also extended to the Chairmen of the various sessions: Dr. William Jackson, Dr. Frank Withrow, Dr. Howard Quigley, George Thompson, George Propp, Dr. Stanley Roth, and Dr. Gilbert Delgado.

I should like to make special mention of the efficiency of the conference staff: Mr. Norman Anderson, Dr. Joseph Giangreco, Dr. John Gough and Dr. John Wiley who were recorders; Mrs. Marjorie Clere and Mrs. Barbara O'Mara who were interpreters; Mrs. Sally Snyder, Symposium Editor; Mr. Bill Bowmaster, Conference Coordinator; George Propp and Bob La Gow, Project Directors.

Special recognition should go to Dr. Frank Withrow, Director, Division of Educational Services, Bureau of Education for the Handicapped, and Dr. Gilbert Delgado, Chief, Media Services and Captioned Films, for their wise counsel and support. The conference staff and participants are most grateful to Media Services and Captioned Films for providing the grant which made the Symposium possible.

And last, but by no means least, special applause goes to our co-sponsors in this year's conference: The Southwest Regional Media Center for the Deaf and Project LIFE.

The schedule of activities at the Conference is printed in Appendix A. A roster of the participants may be found in Appendix B. The report of this conference, as was true for the 1965 through 1970 Symposia, will appear in a special issue of the American Annals of the Deaf, published in the fall of 1971. The Midwest Regional Media Center for the Deaf, University of Nebraska, and Media Services and Captioned Films, U. S. Office of Education are indebted to the American Annals of the Deaf for devoting an entire issue of their journal to this Symposium report.

Dr. Robert E. Stepp, Director
Midwest Regional Media Center
for the Deaf

Mrs. Sally Snyder, Assistant to the Director, joined the Midwest Regional Media Center for the Deaf staff in August, 1969, after completing the Center's Summer Media Institute. Following her 1965 University of Nebraska graduation with a degree in journalism, she worked four years as Assistant Editor of the Nebraska Education News, a weekly newspaper disseminated to the state's teachers. At the MRMCD Mrs. Snyder serves as office manager, interpreter and instructor.

To some people programmed instruction is an educational innovation, new in nature with exciting, untouched vistas. Others reflect on programmed instruction as an educational tool introduced decades ago via the advent of teaching machines. Both outlooks are correct. Some of the most imaginative adaptations of programmed instruction are coming out of people's minds today. However, the nationwide introduction to programmed learning did occur around the 1920's. Later, in the 1960's, the teaching machine appeared as the panacea of pedagogy.

An even earlier link between programmed instruction and education is recorded as having existed in the teaching strategies of Socrates. Similar employment of the stimulus, response, reinforcement (reward) patterning associated with programmed instruction was utilized by a number of nineteenth century psychologists in their experiments dealing with shaping and conditioning behavior. In approximately 1920, Sidney Pressey, a psychologist, developed machines that could teach as well as test by using multiple choice questions. An equally significant name to appear on the programmed learning rolls was that of B.F. Skinner with his theory of reinforcement coupled with the learning program.

As the 1960's dawned, so did the period of experimentation, adaptation and utilization of teaching machines by the score. The innovation of programmed learning via the machine was literally exploding and schools by the droves were "plugging in" their students to a new educational tool. Even though much of this initial enthusiasm diminished when the schools discovered the teaching machine wasn't the cure-all they had anticipated ... some people were not dissuaded. They kept thinking.

Reworking. Building. Writing. Experimenting. Until today, programmed instruction in both written and machine form is truly a potent ally in the educational arsenal.

To document this "coming of age" of programmed instruction, audiovisual instruction texts were consulted to pinpoint its evolution. Plus its growing impact on education. Three editions of Audio Visual Materials by Dr. Walter Wittich and Dr. Charles Schuller quite vividly reveal its history. In the First Edition (1953) there was not one word concerning teaching machines or programmed learning/instruction. In the Third Edition (1962) programming had acquired the status of a full chapter entitled "Teaching Machines and Programmed Learning". This chapter was devoted to the teaching machine and its related programs. No mention was made of programmed instruction in either written text form or filmed format. At this time "the machine age" was claiming sole publicity. By the Fourth Edition (1967) "Programmed Instruction" was the chapter heading and teaching machines were only a small subdividion. Particulars in this chapter included an in-depth view of programmed instruction via printed text and machine, programmed instruction's current status, evaluation and the selection of programmed instructional materials. A current all-encompassing source of PI information (publishers, devices, references, subjects, etc.) has been assembled and published by Carl H. Hendershot. Its title: Programmed Learning: A Bibliography of Programs and Presentation Devices.

As programmed instruction was undergoing this decade of ascent into educational relevance, educators were experiencing this same awakening. As programmed instruction data expanded and received more scrutiny through research and evaluation, more educators embraced its validity. It was this growing professional and personal curiosity which brought these educators and programmed instruction together March 22-23-24, 1971 in Lincoln for a national Symposium on Research and Utilization of Educational Media for Teaching the Deaf.

The time was prime! "Programmed Instruction for the Deaf Student" was more than ready for examination by a national cross section of educators of the deaf. Lincoln, Nebraska was the proving ground.

All participating educators were at some level of understanding on what might be called the abstract to concrete spectrum concerning programmed instruction. It is one thing to read about programmed instruction in textbooks, but most people feel like an outsider looking in on the subject. Interest and knowledge is broadened in programmed instruction by reading actual programs or viewing teaching machines in operation. Seeing students in a classroom setting working with programmed instruction materials adds depth to understanding. A further experience in exposure would be seeing programmed instructional materials produced and implemented by fellow colleagues. Or better yet, seeing the application of a variety of programmed instruction currently in use in classrooms for the deaf. Methods of evaluation are also integral. Then add the critical, crucial element of personal interaction with these individuals who employ programmed instruction in their teaching. This was the prime objective of the Symposium ... exposure and involvement. Plus a thorough thinking through of the subject ... why programmed instruction?

Programmed instruction has suffered the traditional slings and arrows of educational controversy. As with any mechanical invention which threatens to replace a human entity, there is a great deal of defensiveness on the part of the person in "jeopardy." Programmed instruction received this predictable apprehensive reception. It was initially preceived as the mechanization of teaching. A usurper of each educator's territory and role. For programmed instruction to become recognized as an extension of the educator has taken much time. It will continue to require time.

For an educator to utilize programmed instruction he must first define his working relationship with this medium. Sometimes programmed instruction is adopted as the sole conveyor of all data within the classroom and the teacher withdraws to the role of monitor. This is not the intent behind programmed instruction. A more favorable relationship as noted by Lysaught and Williams in A Guide to Programmed Instruction would let "the program supply the student with the basic information of a given subject and free the teacher from the drill-type exercises he must engage in term after term. While the student thus acquires a foundation in a subject to be ready for the far more important consideration of causes, relationships, and applications, the teacher will be released to undertake more creative assignments with students who have been prepared for the challenge. Indeed, since students will progress at their own varied rates, the task of the teacher will become more complex and even more vital."

One cannot overlook or minimize the importance of the learner in this teacher, programmed instruction, student triangle. What might be his thoughts? Conjecture might list first ... independence. When a child is interacting with any form of programmed instruction he is his own master. He is in control. He is in command. He can be fast or slow in his study habits. He does not have to conform to the traditional omnipresent class lock-step progression mold. With programmed instruction there is also active, overt student participation even though the subject under consideration might involve covert comprehension. No one enjoys sitting passively while data is poured into their brain bank. Another vital consideration favoring programmed instruction from the student's point of view might reveal that this type of learning is a highly personal experience. In the seclusion of his own programmed instruction materials he can succeed or more importantly fail in private. Too often we forget the denegrating ramifications of repeated public (classroom) failure on a young, thriving mind and spirit. Also, programmed instruction through its immediacy of results, satisfies a most basic human drive. That is the drive for success. When there is continual reinforced success, the psyche's personal accomplishment ratio takes a healthy leap and demands continued stimulation.

The integration of programmed instruction into classrooms for the deaf has yet another strong, salient selling point. The knowledge explosion we are experiencing is understandably compounding by the year. It will never lessen. Programmed instruction is the logical auxiliary to ease this crush of data dissemination. Then the teacher-student relationship can dwell on education rather than training, thinking rather than remembering.

Hubert Summers attended California Baptist College in Riverside, California where he received a Bachelor of Science in Social Science. He received his Masters of Science in Education of the Deaf from Gallaudet College in Washington, D. C. and is a doctoral candidate at the University of California at Berkeley. Mr. Summers has taught at both the New Mexico School for the Deaf and at the California School for the Deaf at Berkeley. He also served successively as Supervisor of Auditory Training and Dean of Students at CSDB. Prior to his teaching experience, he worked as a dormitory counselor at the California School for the Deaf, Riverside. He joined the staff of the Southwest Regional Media Center for the Deaf in 1968 as Curriculum Coordinator. Mr. Summers was appointed Project Director of the SWRMCD in September of 1970.

Ramon Rodriguez attended Gallaudet College in Washington, D.C., where he received his Bachelor of Arts in Education of the Deaf. He earned his Master of Arts in School Administration and Supervision at San Fernando Valley State College, Northridge, California. Mr. Rodriguez taught in Austin, Texas at both the Alexander Graham Bell School for the Deaf and at the Texas School for the Deaf. Immediately prior to coming to the Southwest Regional Media Center for the Deaf he served as Consultant for the Hearing Impaired for the Cleveland, Ohio Public Schools. Mr. Rodriguez joined the SWRMCD staff two years ago as Curriculum Coordinator.

Robert Edwards attended Drexel Institute of Technology in Philadelphia where he received a Bachelor of Science in Business Administration. He received his Masters of Science in Special Education from Gallaudet College. He taught at the New Mexico School for the Deaf in Santa Fe. In 1969, he joined the staff of the Southwest Regional Media Center for the Deaf as a Curriculum Specialist. His major responsibilities include planning and conducting workshops in programmed instruction and systematic development of instruction, disseminating information on and coordinating production of teacher-developed programmed instructional materials.

Introduction

Programmed instruction is a major area of emphasis of the Southwest Regional Media Center for the Deaf. Our efforts, however, are not directed toward production of material by the Center. We welcome this opportunity to describe our interests and activities in programmed instruction as they relate to our program as a whole and to what we think the major thrust of our program should become.

During this fiscal year, the Southwest Regional Media Center for the Deaf will have conducted the following activities. The list is far from inclusive:

1. Twenty-five workshops in media production and utilization for teachers and teachers in preparation.
2. Nine Project Hurdle assignments (placement of SWRMCD personnel in schools for extended periods to provide in-service training in media production and classroom utilization).
3. Two workshops in media for administrators.
4. One workshop in programmed instruction for administrators.
5. Two concurrent six-week institutes in programmed instruction and instructional systems for teachers, supervisors and/or administrators.
6. One conference and follow-up for planning a cooperative course design project involving at least three schools.
7. One workshop in systematic design of instruction for school personnel with in-service training responsibility and follow-up support to facilitate training of teachers by the participating individuals.
8. A clearinghouse activity to collect and disseminate information on and hard copy of teacher-developed programmed instructional materials.

9. A conference involving staff from several programs to identify cooperative procedures to facilitate coordinated local development of programmed instructional materials.

Several of the above activities will be described in more detail below.

In our view, the Center's program is being drawn together in a way which will permit this Center to make a significant contribution toward promoting the systematic development of effective instruction in schools for the deaf.

Experience has shown that it is not enough to train teachers to produce and use media. This Symposium undoubtedly reflects the conviction that without supervisory and administrative support, media cannot effectively permeate the school's instructional program. In our Center's program, for each training activity directed toward the classroom teacher, we are providing complementary services directed toward the supervisor or administrator. One of our challenges is to communicate effectively with all levels of the educational hierarchy who are essential to successful diffusion of the practices which we advocate.

An equally important challenge is to influence educators to view media and programmed instruction as well as other instructional resources from an educational technology (systems) viewpoint.

Although we are convinced that visual media can improve the educational opportunity of a deaf child, media alone is not the answer. Similarly, P.I. alone is not the answer. What might be closer to an answer is a concept, a point of view, that requires a shift in conceptual framework from viewing an instructional system as a collection of devices and assorted software to a view of the system as a process through which media, P.I., and other learning resources (human and non-human) are systematically, logically, and empirically related to reach educational goals and achieve learning objectives.

Let me demonstrate in a graphic way relationships among our various activities which we believe will enable us to communicate with various strata of the educational hierarchy and which at the same time provide for tangible results which can in turn be disseminated.

(see flowchart page)

I would like to emphasize the following items:

1. In programmed instruction we are deliberately trying to reach both teachers and their related supervisory personnel.

2. In media we are similarly reaching various levels of personnel.

3. Where possible, we are trying to build upon previous knowledge by involving certain persons in successive experiences with, we hope, cumulative effect.

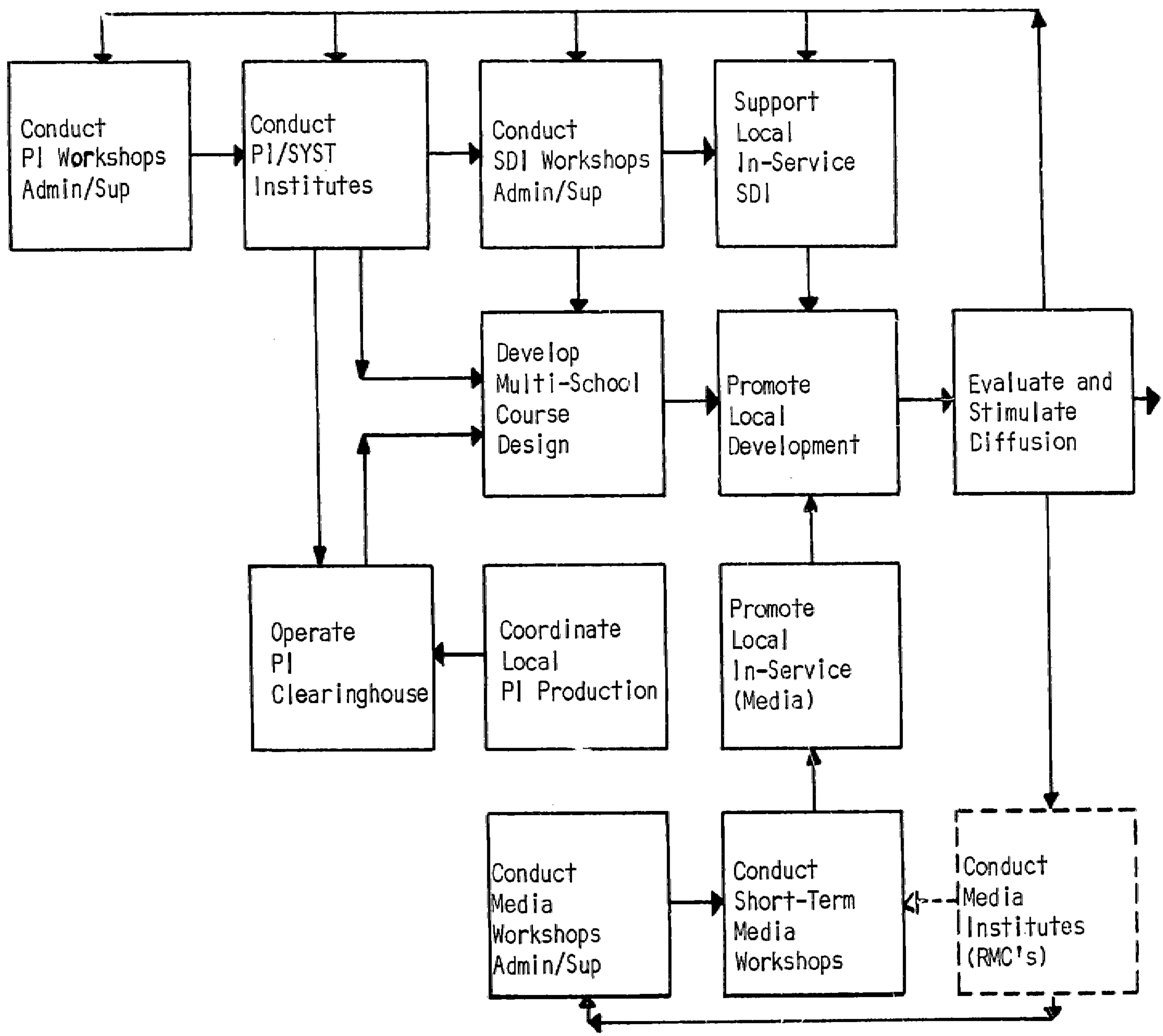
4. We are attempting to capitalize on training, which we have provided, to facilitate development of instructional systems approaches to solutions of instructional problems.

5. We will be making an effort to promote local curriculum development activities resulting from our training program (efforts).

6. We are attempting to capitalize on training we have provided to facilitate the availability of programmed instructional materials.

7. We will be making an effort to promote diffusion of materials resulting from our training efforts if they are of demonstrated effectiveness and curricular validity.

S W R M C D   P R O G R A M   C O M P O N E N T S



8. As our own conceptualizations mature, we hope to achieve a more productive interaction between the "media" and "curriculum" aspects of our program such that, as a result, media will be viewed in its proper perspective and utilized more effectively in instructional approaches that permit successive improvement and greater accountability.

9. Our goal is to stimulate improved instructional effectiveness and increase learning efficiency for deaf students. These are measurable outcomes and the strategies to produce them will be many and varied.

Since 1968, the Southwest Regional Media Center for the Deaf has conducted summer institutes in programmed instruction and instructional systems. Teachers, supervisory level persons, and administrators of programs for the deaf are invited, on a nationwide basis, to attend.

Introductory and advanced institutes were conducted concurrently in 1969 and 1970. Two basic institutes in programmed instruction and instructional systems will be offered in the summer of 1971. One of the institutes is specifically designed for teachers and supervisors specializing in vocational education.

The institutes are intended to make participants more informed consumers of programmed instructional materials. In the process, they receive training in the principles and techniques for the development and utilization of such material. As a part of the course requirement, participants design and develop programs. In most cases, the programs are developmentally tested with deaf students.

The institutes have been well received by participants and have resulted in many concrete developments at the instructional level.

As an example, three schools have assigned participants to full-time programming positions. Several schools have released participants part-time to develop programmed materials specifically designed to deal with recognized instructional problems. As a direct result of our institutes, three teacher preparation programs within our region offer courses in programmed instruction or incorporated relevant training in existing course structures. Further, many of the participants have, on their own time, developed materials to deal with some of their own specific instructional problems.

Some additional spinoffs include: several workshops conducted in schools by our institute alumnae both with and without consultant support; a participant-developed program to teach teachers how to write behavioral objectives used in a statewide meeting of special education teachers sponsored by a state department of education; brown bag meetings at lunch where institute participants are spreading the word through use of available mediated materials; teachers-in-training who are evaluating and modifying teacher-developed P.I. materials for use in their practicum experiences; teachers using commercially available materials and adapting them to their students' needs in a variety of ways; teachers voluntarily using behavioral objectives to guide their instruction of deaf children.

It became clear that if the institutes were to contribute significantly at the instructional level, educational decision makers had to be made aware of the potential of programmed instruction in meeting some of the educational needs of deaf children. A short-term workshop was designed for administrators and supervisors to acquaint them with concepts and principles of programmed instruction. Thirty administrators and supervisory level personnel from the Southwest Region have participated in three workshops.

The programming process (identifying needs, target population characteristics, developing measurable instructional objectives, designing interactive instruction, developmental testing, revising, and validating) has obvious application to a wide variety of materials and activities. The Center staff began to explore its implications as the nucleus of a model for the design of instruction. It was recognized that the programming process could be applied in the systematic development of strategies including materials and media to attain specific objectives related to broader educational goals which guide the development of a larger instructional system. This resulted in the conceptualization of a systematic development of instruction model. The model has the potential to provide instructional planners in schools with a design for effective planning, development and evaluation of instruction. The workshop applying the model is presently making major use of commercially available training materials.

The Systematic Development of Instruction (SDI) Workshop was first tried out with six teacher preparation personnel from programs in deaf education in the spring and autumn of 1970. Valuable feedback was received to modify the training program. As a product of this workshop the six individuals designed a segment of instruction for their training programs. This resulting material will be disseminated to teacher preparation programs later in 1971.

An SDI workshop was held for supervisors having in-service training responsibility in February, and a follow-up workshop is scheduled for June. Upon completing the SDI program, it is expected that participants will be able to provide in-service training to their teachers in the systematic application of instructional design principles which in turn will provide a conceptual framework within which media can be used more effectively.

Discussions with the participants indicate several planned methods for effective utilization of the training model and materials: An in-service training program initiated during the school orientation period and continued through regularly scheduled sessions; use in a Title I supported curriculum workshop during the summer; special courses using the training model and materials and providing university credit; in-service programs involving college credit.

What particularly pleases us is the fact that these outcomes can be effected with little or no direct involvement by our staff. In this way our efforts can be multiplied far beyond what we could accomplish with our limited time and resources. What concerns us is our knowledge of weaknesses in the training materials. It is our hope that we can remedy some of these weaknesses by developing substitute and supplementary materials within the next year.

Another by-product of our interest in programmed instruction and instructional systems is a multi-school course design (MSCD) activity.

This activity will involve the participation of teacher-subject matter specialists from four schools in the Southwest Region.

Collectively, they will design a semester course in upper elementary social studies. The design will include the specification of goals and measurable objectives, development of instructional strategies relating to the objectives, identification of appropriate media, including that which is currently available in the Media Services and Captioned Films depositories, and design of evaluation procedures. It is expected that participating schools will field test the course in the 1971-72 academic year.

In the fall of 1970, the Southwest Regional Media Center for the Deaf initiated a clearinghouse activity for programmed instructional materials developed by educators of the deaf for students in their classes or schools.

A catalog of abstracts was compiled. It included programs developed by participants during our summer institutes in programmed instruction. As additional programmed materials were identified, abstracts for these programs were included in the catalog also.

The catalog contains an index. Programs are listed by subject area to enable the educator to quickly ascertain what programs developed for use with deaf students are available for his area of instruction.

Each abstract contains the name of the programmer, title of the program, and objectives stated in performance terms to inform the educator what the program will enable the student to do, under what conditions. It also contains a description of the target population, identifying the program's level for intended use and developmental or validation testing history. Statements of future plans for testing are also included.

Through questionnaires sent out to all participants of our summer institutes in programmed instruction and instructional systems, the Center was able to identify those participants who have developed additional programs and those who have done further testing on programs listed in the catalog. These people were requested to send copies with abstracts of their programs and additional testing data to our Center. This information will be made available through supplements to the catalog.

A catalog has been mailed to each of the participants of our summer institutes and short-term workshops in programmed instruction for administrators. Other educators desiring a catalog of abstracts can receive one by sending their request to the Southwest Regional Media Center for the Deaf.

The Center has on file master copies of all programs listed in the catalog. Xerox copies of the programs will be duplicated and sent upon request. A charge will be made to defray reproduction and mailing costs. This will be based on the number of pages required to reproduce the program. The number of pages is listed with the title of the program in the index. As adequate field-testing data becomes available, other methods of reproduction of the programs will be considered by the Center.

It is hoped that the clearinghouse will enable more teachers of the deaf to utilize programmed materials in the classroom as well as to encourage them to develop additional programs for their students and share them with other teachers.

At present, the lack of commercially developed programmed materials, which to our knowledge can be used successfully with our deaf students, suggests a need for teacher-developed programs. A handful of teachers cannot meet this need. Through the clearinghouse activities, all educators of the deaf who wish to do so can have a part in contributing programs for others to use. In addition, they can receive the benefit of the experiences and efforts of other educators in developing programmed materials.

In January, the Southwest Regional Media Center for the Deaf conducted a conference to develop a cooperative system to facilitate coordinated effort among a limited number of programs for the deaf in developing and evaluating programmed instructional materials.

In this meeting some tentative agreements were made. We took cognizance of the fact that it is difficult to match student characteristics to instructional materials. The usual grade level designation is essentially meaningless. It was decided that these co-operating schools would use a language level designation as a major basis for matching materials to students. The language levels will be essentially those used by Project LIFE. In this way the language level of a program can be operationally defined as including language structures of certain types and excluding all others. Thus a programmer may arbitrarily restrict language patterns, regardless of content area, and develop a program. Thereafter, a teacher-user may select a program on the basis of content and language structure appropriateness.

Agreements were also made in terms of format for "receptive" programs. Details of field test and data reporting procedures to be used by the cooperating schools will be determined this spring.

Information and materials resulting from this cooperative venture will be incorporated into the clearinghouse function.

The cooperating schools, as well as our Center, welcome additional cooperating participants. It is our hope that in this way more useful information about effective programmed material will be available to teachers. Until more desirable methods of reproduction are in effect, we expect these materials to be available through our clearinghouse activity in the form of masters for local duplication.

It is our hope that we can increase the value of materials reported through the clearinghouse activity by adding emphasis on validation test design in our training programs and by providing consultation to schools which are committed to obtaining student performance data which will objectively indicate the effectiveness of particular programs. Further, we are interested in promoting and reporting the evaluation of commercially available materials which might be adapted or used without modification.

Through an institute follow-up survey, we have attempted to identify commercial P.I. materials which are being used with deaf children. To date we have identified the materials listed later. It is important to note that few if any of these materials have been evaluated in any systematic way. We know that teachers like some of them. We know that students like some of them. But we do not know what or how well students learn from them.

Conclusion

We have described a variety of our activities either involving or conceptually related to programmed instruction. To some, the Southwest Regional Media Center is identified with programmed instruction. To us, however, it is but a part of our major commitment. Programmed instruction, viewed broadly and in terms of its developmental process, points a way toward improvement of instruction for deaf children or for that matter any children. As a process, its application is limited mainly by the level of vision, creativity, and commitment of its developers and users. Many things must happen before programmed instruction or related technological concepts can have a wide and beneficial impact on the education of deaf children. Most importantly we all must make some important value judgments in terms of purposes, goals, and objectives. This is the first lesson to be learned from programmed instruction.

COMMERCIAL PROGRAMS IN USE WITH DEAF STUDENTS
AS INDICATED BY OUR SURVEY
(Listed by Publisher)

Allied Education Council Distribution Center PO Box 78 Galien, Michigan 49113	Mott Reading Program Fitzhugh Plus Programs Book 101 Shape Matching 102 Shape Completion 104 Shape & Analysis Sequencing 201 Alphabet & Common Nouns 202 Action Verbs 203 Addition 302 Placement Guide & Teacher's Manual
Ann Arbor Publications 610 Forest Ann Arbor, Michigan 48105	Programmed Learning, A Practicum
Behavioral Research Laboratories Ladera Professional Center Box 477 Palo Alto, California	Sullivan Reading Program Programmed Geography Sullivan Math
California Test Bureau Division of McGraw-Hill Book Co. Del Monte Research Park Monterey, California 93940	LSI Programmed Reading
Educational Projections Corp. PO Box 1187 Jackson, Mississippi 39205	42 Programs in Vocational Exploration Reading Readiness Filmstrips
Graflex 3750 Monroe Avenue Rochester, New York 14603	Addition of Like Fractions Learning About Fractions Multiplication Time Telling
Grolier Educational Corporation 575 Lexington Avenue New York, New York 10022	Programmed Spelling Elementary Level
Ginn and Company Statler Building Boston, Massachusetts 02117	Ginn Tutorial Comprehension Book The Big City

D C Heath & Company 285 Columbus Avenue Boston, Massachusetts 02116	Agreement of Subject and Verb Capitalization Commas
Lycns and Carnahan, Inc. 407 East 25th Street Chicago, Illinois 60616	Handwriting with Write and See
McGraw-Hill Book Company 330 West 42nd Street New York, New York 10036	Programmed Grammar Sullivan Math Geography (Buchanan Series) Understanding Fractions Sullivan Reading Program
A.J. Nystrom & Company 3333 Elston Avenue Chicago, Illinois 60618	Learning to Use a Globe, I & II Learning to Use a Map
Pronto Printers 1940 H Street Fresno, California	Arithmetic Fundamentals
Harcourt, Brace & World, Inc. 757 Third Avenue New York, New York 10017	English 2600 (Revised) English 3200

Other copyrighted material:

A.G. Bell Association for the Deaf, Inc.	The Language of Directions, A Programmed Workbook by Mary Lou Rush

Waunita L. Garner is Programming Chief of Project LIFE, National Education Association, Washington, D. C. She was an instructional systems design specialist, senior editor in instructional programming, and a civilian training instructor with the U.S. Air Force until August, 1968. At that time, she joined the LIFE staff as a program design and evaluation specialist.

Charles E. Zerrip, Jr., is Coordinator of Program Development, Project LIFE, National Education Association, Washington, D.C. He was an instructional systems design specialist, instructor of programming with the U. S. Air Force until his retirement in September, 1968. At that time, he joined the LIFE staff as director of Programming and Instructional Design.

Educational institutions across the country are presently stressing the importance of individualized instruction. This mode of academic presentation is also known as prescriptive, clinical, or diagnostic teaching and it supposedly has the unique characteristic of being tailored to the individual needs of a given child. A brief survey of the field will reveal that thousands of instructional programs are available. The baffling question that teachers are constantly faced with is, "How do I decide which program of instruction will be the most beneficial to my students?"

In a presentation at the Council for Exceptional Children Convention in San Antonio in December 1970, Dr. Gilbert Delgado, Chief, Media Services and Captioned Films, Bureau of Education for the Handicapped, U.S. Office of Education, referred to criteria for material selection. He summarized those criteria as offered by James Popham, and referred to them as the three "C's":

1. Cosmetic - What does the program look like? Is it attractively packaged? Does the artwork, layout, and presentation have appeal to administrators, teachers, and children?
2. Charisma - Who wrote it? Who published it? Who has used it?
3. Content - What is the program composed of and what does it actually do?

Unfortunately, too frequently the cosmetic and/or the charisma features are the only criteria used for selecting instructional materials. The vital third component - "content" - is too frequently omitted as a basis for selection. The teacher may ask, "Aren't there checklists for evaluating programmed materials?" There certainly are, but most of them are written in general terms in order that the widest possible audience might be reached; consequently, they usually prove of little value to the classroom teacher of the handicapped child in evaluating programmed materials for possible use by her students.

Realizing the deficiency summarized above, the present authors have written this paper in hopes that the ideas presented herein may prove of some value to the classroom teacher. It should be mentioned that the paper is not intended for the person who has had a considerable amount of experience in programming. Rather, it is written primarily for the classroom teacher who is faced with the very practical task of deciding what programs, if any, would be of value to her students.

Analysis of Need

You may, if you are not already a classroom teacher, wish to do a bit of role-playing. Please assume that you are a classroom teacher of severely hearing impaired children. You are in the process of planning next week's lessons. You would like to use programmed instructional materials if some were available and appropriate. What must you do? How do you go about making such a selection? Obviously, you need some criteria for your selection.

The form for selecting programmed instructional (PI) materials is attached to this paper. It will be noted that the form is composed of three sections. The first section provides an analysis of the program need. The completion of its three items will indicate to the teacher what the programmed lesson will accomplish, and precisely what it is intended to do. As Dr. Robert F. Mager once said, "If you're not sure where you're going, you're liable to end up someplace else -- and not even know it."

The first item under Analysis of Need is the purpose of the lesson. As a teacher, you are concerned with both the transmittal of information as well as the comprehension of it by your students. A vital question centers around whether or not the students need the information that is provided them. The purpose should be specific and should limit the lesson to something that can be accomplished within one class period. If the initial purpose extends over several periods, it should be subdivided again until it is manageable within a given period of time. The following examples lack the qualities of acceptable purposes: To write a story; To solve some math problems; To teach a language lesson; To introduce a rule of language; and the like. All of these are too broad and lack the prerequisite of specificity needed for meaningful purposes. Certainly, lessons based upon these purposes would not be presented by any two teachers in the same manner, nor would students gain the same type of information from the lessons.

Some better entries for the purpose item of the checklist might be: To rewrite a story, converting it from direct to indirect discourse; To introduce the concept of prime numbers; To review long division problems (problems not exceeding three place dividends and two place divisors and without decimals).

A purpose that is specific provides the teacher with a precise indication of what the lesson will accomplish. It may also indicate how it intends to accomplish that specific purpose. A subsequent and closely related evaluative factor revolves around the demonstration of student accomplishment. The student must overtly demonstrate that he has reached mastery level of particular goals. Item B of the checklist requires this information in the form of behavioral objectives. The objectives must specifically state what each student should be able to do in order to demonstrate fulfillment of the lesson purpose. Please note that the emphasis is not on how the teacher will accomplish the purpose; rather, the focus is on the student and how he will show that the program or teacher was successful in accomplishing what was set forth.

As with the purpose, the behavioral objective must be specific. An additional element is that behaviors specified in the objectives must be measurable. The items listed below resemble behavioral objectives, but fail by either being too broad or lack the quality of being measurable:

1. Given a math worksheet, the student works 80 percent of the problems correctly;

2. Understands when to use the present progressive form of a verb; and

3. Writes a good story about his summer vacation.

The following entries for section IB of the evaluation form meet more of the criteria for acceptability:

1. Solves 8 of 10 single column addition problems of no more thar three addends;

2. Selects those visuals that illustrate the given forms of a verb;

3. Writes a 60-word paragraph about his summer vacation. The paragraph must contain a topic sentence, at least three compound sentences, and one compound-complex sentence.

Two thirds of the analysis of needs has been completed. However, possibly the most critical entry still remains--the measurement of the satisfactory fulfillment of objectives. Section IC requires that several test items be listed that are designed to measure the objectives of the lesson. These items should measure the concepts presented in the lesson and the application of these concepts, as opposed to requiring the repetition of specific facts.

In constructing test items, there are two factors of prime importance: (1) The item must measure the objective; and (2) The stimulus controlling the correct response must be proper. In the former, what could be a perfectly valid test item may measure a concept that is not a part of the objective. In the latter, the item may measure a concept that is part of the objective, but the stimulus that controls the correct response may be inappropriate. As the test items are constructed, there must be a continual comparison of each item with these two vital factors.

Appropriateness of Content

When the needs have been identified through the lesson purpose, the lesson objectives, and the test items, the programmed materials are examined for appropriateness (See Section II). It should be emphasized that the teacher is generally searching for a specific piece of material to satisfy the needs as previously outlined. A preliminary check of titles and subject matter areas of available programmed materials may provide a number of possible selections. The purpose of one of the seemingly suitable programs should be examined. By following the guidelines provided, it may be noted that the program must be rejected if there is a mismatch between the purpose of the program and the teacher's objectives. If the purpose is simply missing, or if the teacher is undecided regarding the manner in which her purpose and the program's purpose match, she may continue with the check list and examine the behavioral objectives of the program.

The purist version of a behavioral objective requires three parts: the givens, or those conditions required during the performance phase of the objective; the specific behavior to be demonstrated by the learner; and the criteria, or the standard that the learner is to achieve in order to demonstrate competency. In the real world of material examination, it is a rare instance when all three components of the behavioral objective are provided. Usually, the conditions are given only when they are unusual or might not have been anticipated by the teacher. The standard of performance is usually omitted, thus allowing the user (or in this case the teacher) to set the acceptable standard. Some programmers, during the validation phase of an instructional program, indicate that the student must respond correctly to 80 percent of the examination items in order to accomplish the objectives. Certainly, this factor varies from "error free learning" to an error rate anticipation of greater than 20 percent.

The behavioral objectives for the program under consideration should be carefully examined to determine how well they match the behavioral objectives as constructed by the teacher. Again, if there is not similarity, the program will undoubtably be rejected for lacking suitability. If a decision cannot be reached, or if the objectives seem to match, then the teacher may proceed to the test items and compare them with the set that she developed. Even before the test items can be fully compared, a standard for validity must be established. Below is an example of the purpose and objectives from one of Project LIFE's language sections (Unit 10, Section B):

The purpose is: "To introduce the concept of to talk as speaking, shown visually by speech balloons, and to extend the concept of to have by using the past tense."

The objectives are:

The student:

a. Selects the visuals that correctly illustrate sentences containing the verb form had.

b. Chooses had to complete sentences identifying something no longer in the subject's possession.

c. Identifies, by means of speech balloons, the activity to talk and/or the person(s) speaking.

The two basic activities required of the student by the objectives are to identify and to select. The choices given to the student are verbal and visual; therefore, the test items are in two basic forms. In one, a picture is presented at the top of the page and the student is required to select the correct verbal response. The other form is a reversal in which the student is given a sentence at the top of the page and is required to select the picture that illustrates the sentence.

If the programmed material has a purpose and objectives such as those given above, then every test item must measure the verb is talking or the past tense of to have. An example of a poor test item might be:

The boy had an apple.

picture of boy throwing away apple core	picture of boy holding a book	picture of boy throwing away a piece of paper

---

The above test item is inherently weak since the student may respond correctly without attending to the word had. Only one of the pictures contains an apple, so the controlling stimulus is apple instead of had. An improved version of the same test item follows:

The boy had an apple.

picture of boy holding an apple	picture of boy eating an apple	picture of boy throwing away an apple core

In the improved version, both the boy and the apple appears in all of the visuals. The controlling stimulus, as specified in the original objective, is had.

Scores of examples of inappropriate test items could be provided. Possibly one more would provide the reader with a broader understanding of the concept:

> A single picture is provided which shows four people--a man, a woman, a little girl, and a baby. The visuals show the man selling balloons and also shows that the mother has just given the baby a green balloon. A speech balloon from the little girl indicates that she is saying, "The balloon is green." The words at the bottom of the page ask, "What is green?" The choices are: the balloon, the woman, or the girl.

The above listed test item is satisfactory if an attempt is being made at measuring the student's ability to discriminate color. However, the test item is invalid for the third objective--"Identifies the activity to talk and/or the persons(s) speaking." In order to measure the stated objective, the copy should read: "Who is talking?" The choices can remain the same: the balloon, the woman, and the girl. With this minor change, the test item is immediately valid.

For a test item to be valid when compared with the objectives and purpose of Unit 10, Section B, it must measure had or is talking. If the copy at the top of the page states that the baby had a balloon and the choices are three pictures, then each picture might optimally contain a baby and a balloon. If the picture at the top of the page shows two boys throwing away apple cores, then each sentence might present the most valid discrimination if they contained the nouns boys and apples. The verbs contained in the sentences or verb phrases, in the case of an elliptical completion, should be different forms of to have and/or past tense forms of other verbs within the student's repertoire. Anything short of this will not necessarily measure the concept of had. This concept also holds true with the verb is talking. Unless the critical and controlling stimulus is is talking, the test item does not necessarily measure what it was intended to measure.

When the test items are examined for a program under consideration for classroom use, there should be a careful evaluation to determine precisely what is being measured and what is the controlling stimulus for each item.

If the program under consideration has survived thus far, after the examination of its purpose, behavioral objectives, and test items, it is definitely suitable for use in terms of meeting lesson needs. However, there remains at least one other factor that must be carefully considered--Is the program suitable for the students under consideration and does it meet their specific needs?

Program Suitability to Child

Section III of the checklist has a number of points that must be considered before making a final selection of programmed materials. Some questions seem to stand out as being most crucial to program consideration. Does the program have a list of prerequisites or entry behaviors that the students must possess before taking the program? Have the students met these prerequisites? If not, a program ideally suited in terms of classroom needs may only become a series of frustrations for the ultimate users, the students. Also, do the students have the vocabulary and understanding of sentence structures that are used in the program? If not, the program will be of questionable value and consideration must be given to its rejection.

How does the program present new material and concepts? Is new information introduced in a clear and straight-forward manner, with only one concept presented at a time? Is the new information used in a meaningful context with the examples and situations, something with which the student is familiar and can identify? Does the information gradually progress from easy to more difficult material so that the student is able to grasp the initial presentation of a new concept, and then grow with the concept as it is presented in succeeding frames? Unless the new material is presented so that it is meaningful to the students, he may respond appropriately during the program, but the behaviors learned will be quickly extinguished for lack of meaningful context, realistic situations, and examples.

As a program presents new information, does there appear to be a logical sequence in order of presentation? Does the program seem easy to understand? Does it appear that the student will be able to respond appropriately as he proceeds through the program? Does the program build toward the test frames and have a built-in review where previously learned items are meaningfully reinforced. How much new information is on each frame? Is the rate of progress suitable for the students? Unless most of the questions receive an affirmative response, the program may not be suitable since it lacks some of the vital characteristics needed for adoption.

In the last review of the program, a summary was made of certain basic program characteristics with particular attention to the introduction of materials and the flow of information. An examination should also be made of the responses required by the student as he progresses through the frames. Are a variety of discriminations required? Or, is the student required to respond to a number of frames with the same correct choices and the same basic discriminations? Are the responses and discriminations that the student must make directly related to the purposes and objectives of the program and lesson? Is the student exposed to the full concept (as defined by the purpose and objectives of the lesson)? How much assistance is the student given on each frame in order to make a correct response? Are cues and prompts used in early frames and faded quickly so that the student must respond with only the minimum of stimulus? How frequently must the student make relevant, thought-provoking responses? Again, unless most of the answers are affirmative, the program may be of inferior quality, and the student may learn what is being presented in spite of the program, rather than as a result of the program.

Failure to advance from entry level, making the same responses to the same set of choices, quickly leads to loss of interest on the part of the student. What other motivational devices, beyond a program's moving forward, are included to sustain the student's interest? Are the visuals attractive, yet simple and clear? Do the visuals and language present situations that are of interest to the student? Is there an inter-relationship among frames, such as an internal story sequence? Does the program appear to be challenging for the students without overwhelming them? If possible, these concepts should be built into a program to sustain the student's interest. Any program that lacks the majority of these principles can soon result in student boredom. A program with good visuals, a logical story sequence, smooth transitional devices, and is meaningful to the student has a much higher probability of maintaining student interest.

Regardless of the manner in which the program has been constructed, their effect can be destroyed by improper administration. The fact that a program fits the purpose and objectives of a lesson very well, that the program is excellently constructed, and that it is interesting and challenging makes little difference to the student if the program's administration is inadequate. The success or failure of a program might well hinge upon such factors as: Is special equipment required? Is it available now? Will it be available when needed for the program? Are their any special skills needed by the student in order to experience success on the program? Is the method of response understood? Is the student feedback or confirmation of results absolutely clear? Does the program allow for self-pacing and provide individual differences for the fast or slow student? All of this may mean that the success or failure of a program depends upon adequate teacher preparation of the total program situation, as well as proper program administration.

The teacher preparation began when it was decided to consider the usage of a programmed lesson, if the program were available, and if it were approrpiate to the target population. Hopefully, Section I of the checklist may have provided assistance in determining the exact needs of the lesson. To complete Section I, an identification was made of the specific purpose for the lesson, a set of measureable behavioral objectives, and several test items designed to measure the objectives.

Section II of the checklist allowed a comparison between available programs and the analysis of classroom needs. Programs that were inappropriate to given needs were withdrawn for reasons of unsuitability. Those programs that matched given needs were then reviewed to determine whether they fulfilled the specific needs of the students regarding suitability, prerequisites, internal characteristics, responses, general interests, and administration.

Very little good teaching just happens! A good lesson requires many things. Planning the lesson takes a considerable amount of time but it greatly enhances the probability of success. This is even more true when considering the usage of a program of instruction. Success in the classroom with programmed instruction does not just happen. Much must occur before the programmed materials were made available to the classroom teacher. However, the most important single factor for the teacher, herself, is the ability to select the proper program from the scores of those available to her. The checklist or evaluation form provided in this paper was included to assist the teacher with the selection process. It was designed to make the selection of programmed materials for the deaf on a more realistic and objective basis by providing certain selection standards. Though the teacher carefully attends to all considerations given herein, she may find that the program still "will not work." Thus, the "chief judge" is not the programmer, principal, supervising teacher, or the teacher, but is the consumer -- the student!

SELECTION OF PROGRAMMED MATERIALS FOR THE DEAF

By Waunita L. Garner and Charles E. Zerrip, Jr.

SECTION I - Analysis of Need

A. What will this lesson accomplish? What is its purpose? BE SPECIFIC.

____

____

____

B. What will the students do to demonstrate fulfillment of the purpose?

____

____

____

____

C. List several test items you will use to measure the objectives. (Your items should measure the concepts instead of specific facts.)

____

____

____

____

____

SECTION II - Does the program content fit the lesson needs?

A. Purpose of this program.

1. Does the program have a listed purpose or a specific content statement? YES____ NO____

2. If YES - How well does the purpose of the program match the lesson purpose? VERY WELL____ NOT AT ALL ____ UNDECIDED____

3. If NO - After a quick scan of the program, does it appear to present material related to the lesson purpose? YES____ NO____

If you check "NOT AT ALL" under 2, reject the program.

If other items of 2 or 3 were checked, go on to B.

SECTION II (Continued)

B. Behavioral objectives of this program.

1. Are there a set of specific behavioral objectives written in terms of student activities included in the program? YES____ NO____

2. If YES - How well do the objectives fit the lesson objectives?
   VERY WELL____
   NOT AT ALL____
   UNDECIDED____

3. If NO - Proceed with caution. It is possible to determine the objectives of a program by careful review of test items and criterion frames, but it is risky.

If you checked "NOT AT ALL" under 2, reject the program.

If other items were checked, go on to C.

C. Examination items for the program.

1. Is there included or built into the program an evaluation instrument? YES____ NO____

2. If YES - How well do the items included with the program match the test items you developed?
   VERY WELL____
   NOT AT ALL____
   UNDECIDED____

3. If NO - How well do the criterion frames of the program correspond to your items?
   VERY WELL____
   NOT AT ALL____
   UNDECIDED____
   NO IDENTIFIABLE CRITERION FRAMES____

If you checked a "VERY WELL", go on to Section III.

If you checked "NO IDENTIFIABLE CRITERION FRAMES", reject the program.

If other items were checked, continue below.

D. For each item included with the program, determine what concept is being measured and what discriminations are required in making the correct response. Compare this listing with the initial purpose in Section I, A.

How well does the total listing of concepts match the lesson purpose?

VERY WELL____ (Go to Section III)
NOT AT ALL____ (Reject the program)
UNDECIDED____ (Get another opinion)

SECTION III - Is the program suitable for my students?

A. Prerequisites

1. Do the students possess the entry behaviors and skills required of a student beginning this program? YES____ NO____

2. Is the sentence structure and vocabulary level suitable for the students? YES____ NO____

If either item is checked "NO", consider rejecting the program.

B. Introduction of new information

1. Is new information introduced in a simple manner? YES____ NO____

2. Is only one concept developed at a time? YES____ NO____

3. Is the information used in a meaningful context? YES____ NO____

4. Is the information expanded by meaningful examples and situations? YES____ NO____

5. Is the information flow from easy to difficult, simple to complex, etc.? YES____ NO____

C. Program characteristics

1. Does there appear to be a logical sequence? YES____ NO____

2. Does the program seem easy to understand? YES____ NO____

3. Does the program build toward test frames? YES____ NO____

4. Is there a spaced review of material? YES____ NO____

5. Is the rate of advancement between frames suitable for your students? YES____ NO____

D. Responses

1. Are a variety of discriminations required? YES____ NO____

2. Are the responses relevant to the purpose and the objectives of the program? YES____ NO____

3. Does the student respond to the complete concept as stated in the purpose and the objectives? YES____ NO____

4. Are cues and prompts used in early frames and faded until only a minimum stimulus is presented? YES____ NO____

E. General Interest

1. Are the situations used in the program of interest to children? YES____ NO____

2. Are the visuals attractive, yet simple and clear? YES____ NO____

3. Is there an inter-relationship among frames in the program? YES____ NO____

4. Do you believe the program will challenge your students, without overwhelming them? YES____ NO____

F. Administration

1. If special equipment is required by the program, will the equipment be available when you need it? YES____ NO____

2. Does the child require any special instructions prior to taking the program? YES____ NO____

3. Are the response techniques and the method of confirmation absolutely clear? YES____ NO____

4. Since the program is individualized and self-paced, are you prepared for the early finishers? YES____ NO____

For items B through E, you will have to make your own decision. If the majority of the checks are in the "NO" column, perhaps this program is not for your children.

All of the points listed under F must be marked in the "YES" column or you must improvise.

Dr. O. Dennis Barnes is currently Director of Computer Assisted Instruction for the National Technical Institute for the Deaf, Rochester Institute of Technology, Rochester, New York.

Dr. Barnes holds the B.A. in Mathematics from the University of North Carolina at Chapel Hill, and the Ph.D. in Instructional Technology from the University of Southern California.

Miss Arlene Finkelstein has been employed at the National Technical Institute for the Deaf for the past two years. Miss Finkelstein received her B.S. in Mathematics from the State University College at Brockport; and is currently taking graduate courses at the University of Rochester in pursuit of a masters degree.

Currently, Miss Finkelstein is involved in two other Computer Assisted Instruction projects at NTID. One is a program (being developed with the Vestibule Math Department) to teach students to factor polynomials, while the other project is aimed at teaching students in Vestibule Science to solve problems in basic chemistry.

In September of 1968 a group of 70 deaf students took their first giant step into an environment composed of thousands of hearing students. It all started in 1965 with the passage of Public Law 89-36 which required that a National Technical Institute for the Deaf be established at an institution of higher learning, to provide hearing impaired students an opportunity to pursue a technical profession.

The Rochester Institute of Technology was chosen as the host institution because of its outstanding history of providing a technical education. RIT has many programs beneficial to the deaf: printing, photography, engineering, art and business. Each NTID student has an opportunity to participate in a work study program and become a part of a well-established hearing college environment.

Thus, on December 20, 1966, an agreement was signed between the United States Department of Health, Education and Welfare and the Rochester Institute of Technology establishing NTID.

The National Technical Institute for the Deaf recognized the potentials of computer assisted instruction. Accordingly, during the early months of determining the direction of NTID, an IBM 1500 Instructional system was purchased. This system provides the concentrations of visual stimuli that deaf students need. Each terminal consists of a television like screen (cathode ray tube) and a random access filmstrip projector. Both of these devices can be used simultaneously to present visual information to the learner.

CAI offers instructional power previously unattainable on a large scale basis. Computers provide two basic tools which other media cannot provide: speed and memory. During the early years of computer development, speed was measured in thousandths of a second. With the advent of integrated circuitry, speed is measured in terms of billions of instructions per second. The educational implications are astounding. The computer can receive, process, and analyze information obtained from thousands of students simultaneously interacting with the computer. Each learner can be helped based on his behavior alone--not on the behavior of an entire classroom. Students can be reinforced, corrected, praised, chided, and assisted in their individual learning processes.

CAI has an additional potentially powerful tool--memory. The first computer could only remember a little over 2000 discrete pieces of information. The new generation of machines has the capacity to remember billions of sets of data. Educators are slowly becoming aware of the power to use in ways heretofore impossible, relevant and useful data stored in the memory banks of a computer. It is the speed and memory characteristics of computers which offer the learner the individual attention so obviously missing from our educational system.

Many of the deaf students who entered NTID in September, 1968, wished to pursue careers in engineering, business, the sciences, and other highly mathematical-oriented scientific and technical fields. An evaluation of the first 70 students revealed considerable deficiencies in mathematical skills. A decision was made to use a computer-based system as a means of assisting the deaf students to prepare for advanced mathematics.

The prime objective of the course developed by the CAI center was to provide NTID students the necessary mathematical skills in order to successfully complete the RIT beginning calculus course. During the summer of 1968 CAI staff members, instructors of Calculus 75-101, and consultants developed a list of skills prerequisite for entry into Calculus 75-101. The CAI center's approach was to diagnose and remediate individual mathematics deficiencies at the eighth to twelfth grade levels.

Because of the importance of the diagnostic aspect of the course, it was named the "Mathematics Diagnostic System", or briefly, MDS.

Since the task of developing the MDS was enormous (developing the objectives, writing the diagnostic test, preparing course material, etc.), a temporary full-time staff of nine people and a CAI consultant were brought together in February, 1969. The staff began by carefully examining the twenty-one content summaries which had been developed by a Mathematics Workshop. From these summaries, the staff converted instructional content into performance objectives. Subsequently, diagnostic test items were developed.

The MDS consists of 21 segments: arithmetic, ratio and proportion, sets, real numbers, exponents, polynomials, relations and functions, equations, graphs, systems of equations, matrices and determinants, geometry, analytic geometry, logarithms, trigonometry, complex numbers, vectors, finite math, binomial theorem, induction, and symbolic logic. The material covers high school mathematics plus a few additional topics found in introductory college mathematics courses.

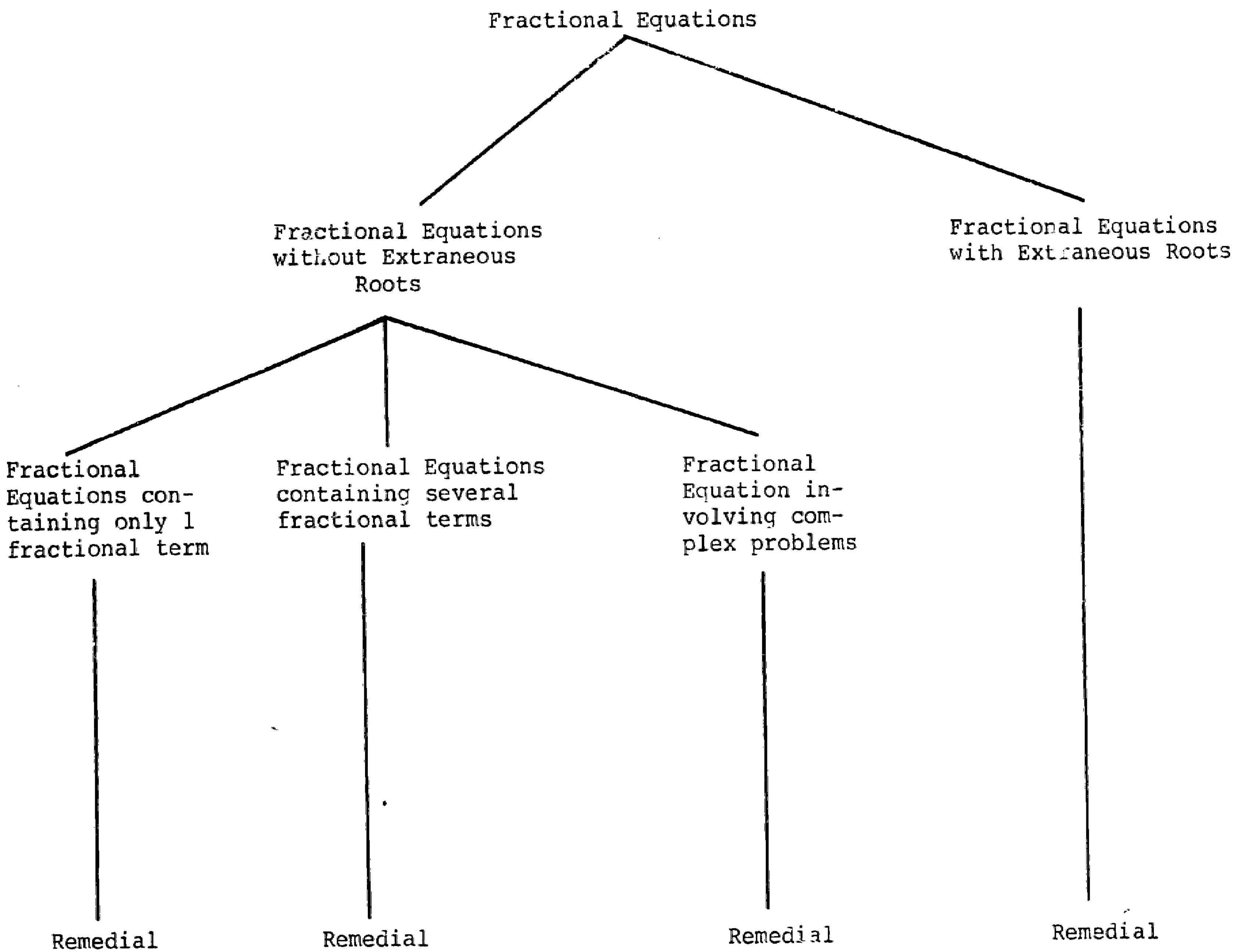
Because the range of material is so broad and the educational backgrounds of the students are so different, the MDS was designed so that a student works full-time in his areas of deficiency and is never exposed to material in which he has shown proficiency.

The structure of the MDS follows this pattern: Consider a student who cannot make instant coffee. Failure to do this activity is usually due to the lack of the enabling behaviors--can he boil water, or measure out a teaspoon of instant coffee into a cup, or does he even know what a teaspoon is?

The rationale for the MDS is based on this reasoning. It is highly unlikely that a student can handle a complex problem if he has not mastered the necessary sub-skills. In the segment on Equations, one of the main diagnostic test items is a top level or complex problem in "fractional equations." If the student answers this complex item correctly, it is assumed that he can solve almost any fractional equation (with or without extraneous roots). If the student answers this item incorrectly, he is directed to "solving fractional equations without extraneous roots" and "solving fractional equations with extraneous roots." If he gets the latter topic wrong, he is sent directly to remedial work. If he gets the first topic wrong he will be directed to three subdivisions, "solving a fractional equation containing only one fractional term", "solving a fractional equation containing several fractional terms", and "solving a fractional equation involving complex problems". An incorrect response to any of these items can lead to remediation (Refer to Figure 1). After remediation the student is branched back to the next diagnostic item.

In the first version of the MDS (MDS-VI) the remediation took the form of worksheets, assignments in textbooks, and the aid of an

Figure 1: Fractional Equations



instructor/proctor. Performance data were collected on the first set of students and used to revise and expand the MDS into a new MDS-V2 that was more computerized. In MDS-V2 the computer not only had all the diagnostic items on it, but also instructional materials that told the student what to do and in most cases taught him his deficiency. This meant less use of textbooks and worksheets and more use of an instructor/proctor to help those students that were having difficulty.

An important aspect of the MDS, or any program for that matter, is the performance recordings. These have been of great use in providing feedback on the diagnostic items. The location in the course of each student on a given date, how long it took to answer a question, the response to each problem, the number of items encountered by each student, and the total number of hours each student spent at a terminal are some of the data provided by performance recordings. Each of these is equally important to the CAI center when developing, revising, or expanding existing programs.

At NTID many other applications are being investigated. A CAI course is given, which teaches A Programming Language. A student can learn, in two weeks, a computer language taught, to him, by a computer. The Vestibulè Mathematics Department is developing several lessons in factoring polynomials. When a teacher determines that a student has a deficiency in factoring, he is asked to take the CAI Factoring lessons. The student is taught how to factor and his performance is guaranteed.

The Vestibule English Department is developing several lessons in grammar. These lessons will help the student constructing grammatically correct sentences. The Vestibule Science Department is developing a modular Chemistry program. The terminal performance expected of the learner is to correctly balance a chemical equation. The lessons, however, begin with correct identification of oxidation numbers and progress to balancing chemical equations. Several other projects are also underway: an electrical engineering circuit analysis course, a unit conversion lesson in chemistry, and a biochemistry course.

As you can see many projects are being evolved. The CAI center closely cooperates with the various departments at NTID. Not only CAI, but PI techniques are being used within the instructional programs. This is especially true when it comes to the fields of math and science at NTID. The math department is using as its main source the TEMAC Programmed Learning Materials--Math Learning Center--produced by the Encyclopedia Britannica Educational Corporation. The Math Learning Center consists of nine math courses, each being divided into 21 major topic areas, and subsequent subdivisions into more than 350 specialized areas. The content of the material ranges from basic mathematics to modern algebra. This type of PI material is used by the math department quite frequently as a supplement to the classroom to provide remedial instruction for the student who exhibits a weakness in certain areas.

For the few individuals that have difficulty in the mathematics of Vestibule Chemistry the science department uses a set of six PI texts, collectively called Programmed Review of Mathematics by R. Flexer and A. Flexer. The six sections are fractions, linear, and literal equations, quadratic equations, exponents and square roots, logarithms, and introduction to statistics. The major emphasis when in use is placed on those topics which are directly related to a chemistry problem--be it setting up a correct proportion or balancing an equation.

The Vestibule Science Department also uses PI materials for their General Science course. These are the TEMAC Programmed Learning Materials for the Biology Unit The Evolution of Life, Sound and Light Unit, Mechanics Unit, and Chemistry Unit. The unit used most often for individual instruction is the Mechanics Unit. The teachers use these PI materials in just about the same way as the math teachers do, i.e., for the student needing extra work and instruction in areas in which he is deficient.

Computer Assisted Instruction provides educators of the deaf, an opportunity heretofore unobtainable. The computer is a machine and will never replace the human interaction so necessary in the learning process. But, the computer provides the educator with an opportunity to tailor instruction to the needs of an individual learner.

The analysis of the learner's behavior and the design of an instructional system guarantee an optimal learning environment. The learning process can be effective and efficient.

Dr. Edgar Lowell is the Administrator of the John Tracy Clinic, Los Angeles. He has held this position since 1954. An additional career he assumed in the same year was that of Associate Professor at the University of Southern California. In 1961, he was advanced to Professor of Education, a position he still holds.

Between 1952-54, Dr. Lowell was a Research Associate and Assistant Professor at Harvard University. During this time, Dr. Lowell was doing graduate work on his Ph.D. in Social Psychology. Previous to the awarding of his Ph.D. in 1952, he attended Wesleyan University and received an M.A. in Psychology. His A.B. in Psychology and Education is from Reed College

Anyone exposed to the news media must have heard about "The New Economics", in one context or another, more than likely as it relates to the Administration's attempts to balance the budget, curtail inflation, reduce unemployment, or some equally impressive maneuver. I knew very little about the old economics, so it was no surprise that I failed to follow the "new economics". I had assumed that economics had something to do with how much money I had in my pocket, or at least the purchasing power of that money. I supposed that it also had something to do with conditions our deaf graduates would find as they entered the world of work. Since these are both matters of concern, it seemed reasonable to attempt to explore the "new economics". This was like sending the proverbial boy to do a man's job, and I must admit to failure. I never did learn just what the "new economics" refers to. Apparently it means different things to different people and depending upon who is doing the interpreting.

In the course of these explorations I did come upon some facts about our economy which, while not necessarily part of the "new economics", were new to me. If I interpret these facts correctly, they may have a profound influence on my work as an educator and most certainly upon the lives of deaf workers. In a way this "new" information is related to technology and technological change, and so seemed a fitting topic for this meeting on technology and education of the deaf.

Despite a firm conviction that the early years are crucial in the education of a deaf child, this has not diminished our concern with the occupational future of the young children we work with at John Tracy

Clinic. Parents are understandably interested in employment opportunities for their children, and it is our responsibility to provide them with realistic and factual information.

I had heard over and over about how the deaf were under-employed.[1] I had also heard about the speed with which technology, and particularly automation in the production of goods, was rapidly eliminating the need for unskilled labor.[2] For example, computer-controlled equipment and new photographic procedures were eliminating the linotype and with it many of the positions formerly held by deaf people.

This, I assumed, was the result of not paying enough attention to technical training for deaf people. If there was to be job obsolescence because of technological change, the solution was to insist on more high level technical training for the deaf so they would have the ability to adjust to these new developments.

I remember discussions about the role the National Technical Institute for the Deaf should play in this problem. Should it be merely a glorified technical trade school, preparing deaf graduates for helpers' jobs, or should it be the MIT of deaf education, whose graduates would be so well prepared that they could keep ahead of the technological advances that were sure to occur? Would the NTID train helpers who were replaced by automation, or would they train those who would, in fact, "run the machines" that replaced the workers?

I was also concerned that our schools were not preparing deaf students to make appropriate use of the leisure time that was certain to accompany this rapid growth in technology. The 40-hour week would be reduced to 35 or 30 hours, and we might all need help in making meaningful use of that leisure time.

Now that I have been exposed to a "new" perspective on our economic future, it appears that most of what I described will never take place. My introduction to this new appraisal of our economic future came from an article by Gilbert Burck.[3] While some of his estimates may ultimately be somewhat in error, the main thrust of his argument is inescapable. His suggestions have thought-provoking implications for the educational and vocational lives of deaf people, and some equally interesting implications for education itself.

Burck points out:

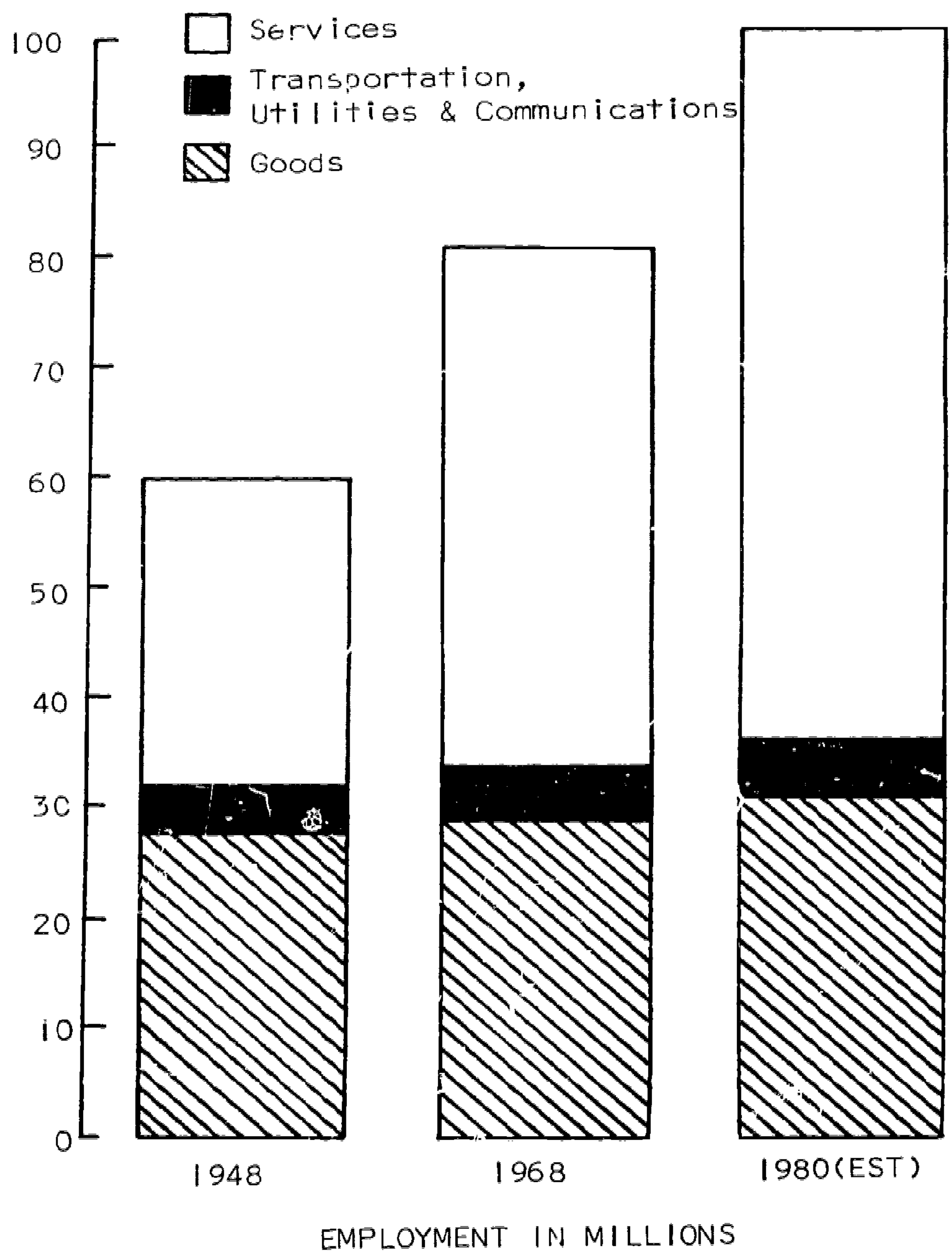
> "Nothing is easier to take for granted in the U.S. than long-term economic growth, and a good many people accordingly take it for granted. The prophets of Automatic Abundance assure us that the economy of the 1970's will grow as effortlessly as crabgrass in a lawn, that technology has solved the classic problem of scarce resources."
>
> "...many A.A.'s believe that the day is near when people will no longer be condemned to long hours on life's treadmills, and that ambitious labor leaders who are warbling about the four-day and even three-day week are only anticipating the inevitable."
>
> "The U.S. is and will remain a 'scarcity' economy--one that allocates its limited resources efficiently through the natural feedback system embodied in the profit motive and the market."
>
> "Now that improving the quality of life has become national policy, productivity growth is all the more necessary. Controlling pollution, reviving mass transit, rebuilding cities, reducing crime, and providing ample medical care and education will put stupendous additional demands on the nation's resources. Only if our productivity, or output per man-hour

keeps rising at least as fast as it has been, can we do all that we want to do without scarificing something desirable and important."

"The catch is that large and rapid shifts in employment patterns may soon begin to depress the rate of productivity growth. Prices of services will rise inexorably, producing new inflationary stresses. Contrary to all the predictions that automation will throw millions out of work, the scarcest of all resources will be manpower."3

His argument is based on an examination of the components of our gross national product (GNP). Burck divides the total output into three categories: Production of Goods, that is, manufacturing, mining, farming, and construction; TUC which is Transportation, Utilities, and Communication; and Services, which incluae government, trade, finance, and personal services. He examines the history of these three components of our economy during the past 20 years and projects what they may reasonably be in the future.

During the past 20 years the output of goods has more than doubled but the productivity of the goods industries increased so much that the number of people required to produce the goods rose by only approximately one million people from 28 to 29 million. During this same period the output of the Transportation, Utilities, and Communications segment also more than doubled but the number of people employed in those areas increased by only a few hundred thousand to some 4 1/2 million. During this same 20 years the number of people providing Services increased from 28 million to nearly 48 million, or an increase of roughly 70%. Thus, services contributed nearly all of the increase in total employment since 1950, as illustrated in Figure 1.



Comparison of total labor market in U.S. for 1948 and 1968 and projection for 1980.

The employment figures are even more striking if we examine the projections for 1980. By that time it is expected that our total GNP will have increased by at least two-thirds and employment will have increased by nearly 25%. The projections suggest that the number of people employed in the production of goods will increase 6% above the present level. Employment in the TUC segment will increase by only a few hundred thousand. The number of people engaged in Service activities will account for the major increase in total employment. It is predicted they will increase to 65 million or nearly two-thirds of all jobs. To give you some comparison figures, 65 million is nearly equivalent to the total employment figures in 1958.

Rather than having to worry about meaningful use of leisure time, our problem is going to be to find enough labor to fill all the jobs.

The differences in the growth of employment in the three sectors of our economy are largely because the very essence of service is generally a one-to-one personal contact, whereas in the production of goods it is possible to increase productivity by additional capital investment. A machine can often be purchased that will either reduce the amount of labor required or increase the productivity of those already employed in the production of goods or the TUC complex.

Furthermore, service workers tend to work fewer hours than goods workers, and are probably less efficient primarily because the Service sector is not highly competitive. Nearly a third of service employment is accounted for by government and private nonprofit organizations. Nearly half have some kind of monopoly position that may encourage them to increase their output, but not necessarily to improve their efficiency.

I must confess that these figures came as a considerable surprise to me. I had no idea that the Service sector required such a large part of our labor market, nor that we faced the built-in limitations to increased productivity.

One implication of this line of reasoning has to do with the future of technology in education. For example, there are nearly five million educators employed by state and local governments. By the greatest stretch of imagination this cannot be thought of as a highly competitive area. The number of teachers increased from 1,500,000 in 1947, or at a rate ten times as fast as the total population and three times as fast as the number of students. If we attempt to measure educational efficiency it is clear that productivity has declined. One might expect that since there are now fewer pupils per teacher, the quality of education would have improved, but there is little evidence for anything like a three-fold improvement in the quality of our output since 1947.

If there is not going to be enough labor to go around, then we must predict that the cost of that scarce labor will continue to rise. Unless there is some drastic change, we must also expect that the trend toward fewer pupils per teacher will continue. Those concerned with fiscal planning and budgeting for education realize that we are not drawing from a bottomless well. Anyone, with even a mild streak of pessimism, recognizes that we may be in for troubled times when there will not be enough money to go around. We are beginning to see some of the effects of this kind of money shortage in our California University and State College system at the present time.

By and large, in the Service sector, it is not possible to substitute capital for labor. There are not many machines that can reduce the amount of labor required or increase the productivity of those already employed. The possible exception, and a very exciting one, is in the field of education. It may be that the consequences of the trends outlined here will force a more rapid acceptance of technology than even the most enthusiastic disciple would have dared to dream. If we cannot find or afford enough teachers, we may be forced to determine the extent to which the machine, in one form or another, can be used to assist the teacher and improve her efficiency.

We may have to rethink a great many concepts that we now hold about how education should be organized. Tomorrow's schools, whether we feel comfortable about it or not, may be much more mechanized. There may be more machine-student interaction, and video-taped lectures may be the rule rather than the exception. The teacher may change from her present role to a combination diagnostician, programmer, trouble shooter and coordinator, and she may end up doing a better job. The implications are challenging, but I wonder if we are ready for the challenge.

Another implication of this line of reasoning has to do with future employment opportunities for the deaf. The opportunities may not be so great as I had anticipated for the highly trained technical person who would "run the machine" that replaces the workers, at least not in the area of goods production. We may need to explore the implications of this dramatic shift of employment to the Service sector for those who have a communication disability. Do we need to re-examine the Service occupations to determine which ones place a premium on personal face-to-face communication, and which place a greater emphasis on technical skills and training? From the array of activities mentioned earlier, one might explore finance. I wonder if competent bookkeepers, accountants, financial analysts, and auditors might not be very successful without having to engage in a great deal of verbal communication. Would a well-qualified stock market analyst be underemployed because he was deaf? If there is to be a shortage of people to fill all of the jobs required in the Service area by 1980, perhaps we should begin some thinking along these lines.

If, as Burck's article seems to imply, the "good life" will generate the need for more workers in the personal services area, will we have to consider some re-education of our deaf students concerning the old fashioned concept of the "dignity of service"?

I admit these are all very tentative questions. They reveal the lack of a comprehensive understanding of the deaf employment situation. On the other hand, I had no idea that in less than 10 years two-thirds of the labor force would be engaged in providing services, nor had I given any serious thought to the difficulty of increasing the efficiency of the Service sector. Even though the figures are less than complete, and my questions possibly a little fuzzy, the implications are quite exciting and deserve serious consideration from all concerned with the deaf.

REFERENCES

1. Education of the Deaf, A Report to the Secretary of Health, Education, and Welfare by his Advisory Committee on the Education of the Deaf. Washington: U.S. Department of Health, Education, and Welfare, 1965.

2. Venn, Grant, Men, Education and Manpower, AASA, 1970.

3. Burck, Gilbert, There'll Be Less Leisure Than You Think, Fortune, March 1970, pp. 87.

Dr. Edgar Lowell is the Administrator of the John Tracy Clinic, Los Angeles. He has held this position since 1954. An additional career he assumed in the same year was that of Associate Professor at the University of Southern California. In 1961, he was advanced to Professor of Education, a position he still holds.

Between 1952-54, Dr. Lowell was a Research Associate and Assistant Professor at Harvard University. During this time, Dr. Lowell was doing graduate work on his Ph.D. in Social Psychology. Previous to the awarding of his Ph.D. in 1952, he attended Wesleyan University and received an M.A. in Psychology. His A.B. in Psychology and Education is from Reed College

A few years ago if someone told you they had a new instructional program that guaranteed student participation, provided immediate knowledge of results, allowed each student to work at his own pace and freed the teacher for more individualized work, I am certain that most of us would have done everything in our power to take advantage of this new system.

Such was, and still is, the promise of automated instruction. The wonder of it all is that there has been no mad race to embrace automated instruction in deaf education.

As an administrator, this poses an interesting topic for self-evaluation. Is it true, as some have suggested, that we are so set in our ways, so conservative, that it takes 20 years for the results of educational research to filter down to the classroom? Are there valid reasons to doubt the potential feasibility or effectiveness of automated instruction?

We have attempted to examine possible answers to these questions, and in the process have arrived at what may be a reasonable compromise for schools for the deaf.

One of the clear-cut deterrents to widespread adoption of automated instruction is simply a matter of cost. Almost without exception the applications that we read about in the literature are substantially financed by the government. There is a danger, however, that we use "cost" as an explanation for all resistance to change, so we have tried to look at other possible explanations.

In what may be oversimplified terms, we are faced with a choice between alternatives of being "too early" or "too late". In responding to the charge of being too conservative, we may be tempted to jump on the "band wagon", but many of us have learned from bitter experience that either extreme is fraught with danger. Rapid technological improvements often make early investments in new devices obsolete or you may even find yourself serving as an experimental subject while a manufacturer gets the bugs out of his equipment. I recall with considerable distress our very early investment in video tape equipment which spent so much time in the repair shop that it was obsolete almost before we learned how to operate it.

On the other hand, what criteria do we use to judge that we are too conservative, that, in fact, the band wagon is passing us up?

The next set of alternatives, which is clearly related to the above, has to do with the size or scope of the automated instruction one is contemplating. This in turn is related to cost.

At one extreme we have Computer Aided Instruction. Some of the estimates on CAI suggest that ideally we can expect costs of about 12¢ per student contact hour. To achieve this goal requires a capital investment in the neighborhood of two million for the computer, almost the same amount for additional memory and output equipment, and perhaps another million and a half for software. To amortize this investment and still stay within the 12¢ an hour figure requires the use of several thousand output terminals at least eight hours a day, six days a week. According to the May, 1970, issue of the AMERICAN ANNALS OF THE DEAF, we have some 1,375 educational programs and some 6,048 teachers, which averages out to some four or five classes per program. Even the most optimistic view of remote terminal time sharing suggests that the potential economy inherent in a large system is probably not going to be immediately available to deaf education programs.

At the other extreme, we find some inexpensive devices which, because of their simplified construction, tend to either lack flexibility or to lock the user into dependence on a particular producer of software.

Most of the programmed material available was either prepared for general education use, which seems to work quite well in some fields but not in others, or requires such heavy financing from the government that it is extremely difficult to see how it relates to the average deaf education program.

A related and not insignificant problem is that a dependence on those materials which the government supported projects choose to produce raises the spectre of the "technologist" taking over responsibility for deciding upon the curriculum for our schools for the deaf.

Faced with this situation, we decided to seek some middle ground. We were willing to trade some of the interactive features of CAI to reduce the cost to levels we could afford to explore and yet which would allow us to develop our own programs in a fairly simple manner.

The solution was a multiple choice response device which could control a slide, filmstrip or motion picture projector. By coordinating the material in the projector with the sequence of correct responses in the device we effectively transformed the projector into an automated instruc- n device. Such a device was fairly simple to construct as long as the sequence of correct responses were fixed and limited. Exploration showed that even young children could readily learn a fixed sequence of correct responses regardless of the material. The solution was devising a series of interchangeable "program plugs" which permitted a simple way of changing the sequence of correct responses.

This device was later modified to suit the requirements of Project LIFE and named the Program Master. Many of you are familiar with the first model of this machine. Two hundred were constructed for evaluation by Project LIFE. The most recent version is a much improved and more sophisticated version produced by General Electric.

The educational material which Project LIFE has developed with such skill over the past years is now designed to be used with this equipment. This provides a school for the deaf with an opportunity to acquire inexpensive hardware and a fairly sizeable accumulation of existing software designed specifically for the deaf, with the prospect of additional material becoming available in ever-increasing quantities.

A major advantage of this system is that it still enables us to produce our own materials quite simply and inexpensively. We can shoot our own materials at not more than 18¢ per slide. We use an old photocopy stand with a 35mm camera and an acetate overlay to represent the response buttons. Text material can be produced on standard or primary typewriters or can be drawn by hand or cut out of books and magazines.

To give you some idea of the scope of programs that have been produced locally, they range from a series on anatomy and physiology of the ear and a geography lesson on the seas of the moon produced by Dr. Harry Murphy in connection with his doctoral dissertation which you will hear more about at this meeting, to a simple familiarization program to teach 3-year olds how to use the machine.

Some of the other programs which have been produced by our staff and used with considerable success with our nursery school youngsters are a series on color and number concepts. In addition to developing a child's language vocabulary, these programs provide an interesting method of observing the sequence of color and number concept development.

Another series designed primarily for reading vocabulary development also provides training in generalization and discrimination. A program on Easter was used in connection with the whole school unit on Easter activities and a series on planting the bean was an integral part of our preschool science program. If interest appeared to lag, a series using pictures of the children themselves on the slides aroused great interest and enthusiasm and also contributed to the improvement of reading skills for the names of all demonstration school children.

Still other series dealt with such items as lower case alphabet letters and perceptual skills in matching geometric figures. We suspect, but we have no evidence, that the latter program may have some diagnostic value.

I would not suggest for a minute that all of these programs were a smashing success in the early stages of our work. We started with untrained people. A little reading and only slightly more experimentation and experience showed them what was required to produce a successful program. Many times the size of the learning increment had to be adjusted to the ages of the children and quite a few slides had to be reshot before we mastered all the photographic variables. Even with experience, some of our attempts failed completely. One program on "how to fold a paper hat," for example, was a total failure.

As more schools begin to develop programs that appear to work with their children, we can envision an exchange or swapping of programs.

It is our belief that the cost of much more sophisticated automated instruction devices will be reduced drastically in the next few years, even hopefully to the level where we can afford them. Along with that there will undoubtedly be the development of more educational material for these devices that will be suitable for our children.

Our decision was whether to wait until that day comes or to seek a middle ground that would provide us with a relatively inexpensive device which would permit our own staff to prepare programs without a great deal of specialized training. We believe that we have obtained a modicum of success with this approach but we would be the first to recognize that it may ultimately be too simple. In the meantime, we have gotten our feet wet, we appear to have generated some grass-roots enthusiasm for automated instruction, and we have a staff that has a much better appreciation of what is involved in automated instruction regardless of how sophisticated some later system may be. We may have found a middle ground.

Mr. James McCarr is a Teacher-Language Co-ordinator at the Oregon State School for the Deaf. Previous work experience includes a one year stint as a part-time programmer for Project LIFE. Mr. McCarr has also spent 15 years in the classroom, being an elementary-junior high school teacher accounts for 10 of the years while the remaining five he was a teacher of the deaf.

Mr. McCarr did undergraduate work at St. Francis College and received his M.S. from the Oregon College of Education.

Panaceas seldom, if ever, exist that solve the problems facing the world. This applies to all areas of life and especially to the area of education of the deaf. The fact that there are problems confronting educators of the deaf is acknowledged by the reports of Babich, Quigley, et alii.

There is no one solution to these problems, but one promising educational tool - Programmed Instruction - offers a remedy to a segment of these problems. It is to the development and implementation of these media - programmed instruction and individualized materials - that the Oregon State School for the Deaf in Salem, Oregon is currently directing its efforts so that the diversified needs of individual students may be met.

A long ranged curriculum development program was initiated at a one week in-service training session for the entire teaching staff prior to the opening of school in 1969. During that week members of the Oregon State School's staff instructed the faculty on the advantages of behavioral objectives and presented a mediated program that demonstrated how to write them. When the teachers acquired the basic skills for writing measurable objectives, the school's plan for revising its curriculum was outlined.

The curriculum revision included the division of the faculty into small groups according to subject areas. These groups met weekly throughout the school year for the purpose of writing performance objectives for each grade from preschool through high school and of organizing the sub-objectives for each level into optimum, sequential steps in each subject area. The sub-objectives for each level were obtained from teachers' lesson plans which were written in behavioral terms. These sub-objectives for each level were then typed on cards and filed according to levels and subject matter.

On one side of these cards is stated the behavioral objective describing the skill that a student is required to perform in a given subject area at a certain level. The reverse side lists the instructional materials that teachers have found to be most effective in helping the students acquire the skill described by the behavioral objective.

Eventually, the school's Instructional Materials Center will have the entire curriculum for each subject area filed on cards; and teachers, following the school's curriculum guide, can go to the IMC and select the objectives and corresponding materials for their respective levels. In effect, these cards will replace lesson plans and allow each student to work independently at his own rate. Placement of students will then be based on the individual student's level of performance.

Because the objectives are written on cards, teachers will be able to revise the objectives or their sequence as well as add new materials to facilitate the student's performance of the objectives. Thus the curriculum can constantly be improved and kept up to date with the development of new media and methods.

Some objectives were acquired from the Instructional Objectives Exchange (IOX) at UCLA for the areas of physical education, mathematics (K-9) and reading (K-9). Others will also be obtained as they become available.

Learning Activity Packets (LAP's) obtained from Hughson Union High School in Hughson, California are being modified for use in the vocational area. Hughson High School has a catalogue of over 500 LAP's. These packets are used by an individual student, and each packet covers a unit of material. The student is directed through a series of activities described by behavioral objectives. Pre-post tests are administered, and the student is given a choice of supplementary activities based upon the student's special interests. Packets already adapted for Home Economics include units on: beverages, breads, and dish washing.

Individualized instruction began in reading classes where programmed materials such as the Sullivan programs from McGraw Hill and Behavioral Research, The Mott Programs from Allies Education Council, and the L.S.I. programs from California Test Bureau were used to supplement basal readers. Other materials which lend themselves to an individualized approach are: Thinking Skills Series, (Barnell Loft), Reading for Concepts, (McGraw Hill), SRA materials, the twenty four Pacemaker Story Books, (Fearon), Reader's Digest Skill Builders, The Kaleidoscope Readers, (Field Educational Publications), Spectrum Kit, (Macmillan), and Step Up Your Reading Power, (McGraw Hill). These are just a few of the materials that are commercially available to schools and can be used on an individualized basis.

In a program such as this, teachers can give students in their classes personal attention; students can work at their own rate and in areas of their own interest; and accurate records can be kept on the individual students which enables the teacher to place the student in the proper level so that he can continue learning with continuity and a minimum of overlapping.

In these classes the reading teacher's main responsibility is to act as each student's tutor and provide the student with materials commensurate to his ability. In the tutorial role the teacher can concentrate full attention to the improvement of each student's ability in areas that present the most difficulty to the student. This approach also enables the teacher to individualize motivation by offering each student materials that best coincide with the student's personal interests. Being able to direct the student to materials that are best suited to his level of skill, the teacher can bolster the student's confidence in himself and enkindle the flame of enthusiasm with the most potent of all motivators - success.

The student is made aware of his success not only by his own personal sense of achievement but also by his individual progress chart. Each student has his own chart on which his daily work is graphed. This tangible evidence of his achievement has proved to be a very forceful motivational factor with the students.

Perhaps the most ambitious and innovative revision of the school's curriculum was in the crucial area of language. Patterned Language, a new system of teaching language, was developed by B.J. Peck, the school's assistant superintendent, and adopted on a school-wide basis in the fall of 1968. Patterned Language is based upon modern linguistic principles and offers the deaf student a means of expressing his desires and ideas linguistically even at the preschool level. It also provides the student with a method of monitoring his expressive language throughout his linguistic development.

Since Patterned Language is naturally compatible to the principles of transformational grammar, a group programmed approach for teaching complex syntactic structures is also being developed.

A semi-programmed instructional manual has also been prepared so that parents can use the first unit of materials in their homes with preschool children. This program has been used successfully with children as young as two years of age. To describe Patterned Language in any detail is beyond the scope of this paper. For further information the reader can refer to the Convention of American Instructors of the Deaf Proceedings, 1969, p. 195.

Fundamental to the success of the plan for curriculum development was the organization of the Instructional Materials Center. In the spring of 1969 three former classrooms located near the school's library were remodeled into the IMC. The two-fold function of this area is: 1) to provide teachers with materials necessary to meet the particular needs of each student, and 2) to make these materials as easily accessible as possible.

The selection of materials to be included in the IMC began with a critical examination of all materials being used in the school at that time. Those that were judged to be successful teaching tools for the school's population and adaptable to the new curriculum were kept while those that could not meet these criteria were rejected.

A great variety of new and current commercially produced materials were then evaluated. Those that met the needs and coincided with the levels of the school's population and could be adapted to an individualized format were chosen.

All of the materials which were selected were organized into four main sections. All textbook and workbook type materials were placed on shelves according to subject matter and level of difficulty. This section includes supplementary reading material and programmed materials in math, social studies, language, and reading.

A second section is devoted exclusively to all duplicated materials. It includes a total of more than 2500 different pages of materials geared mainly to preschool and primary levels. The ditto masters were put in loose leaf binders which comprise the Master Index. The content of these ditto masters are described in a Subject Index to which teachers refer when they are looking for specific materials. When they find the materials they need, they note the code number, go to a group of shelves, find the code number of their materials, and take the amount of sheets needed. If supplies are depleted they are replenished by the secretary. As new masters are made, they are numbered and put in the indexes, and the duplicated sheets are placed on the shelf. Thus the system allows for continual expansion.

Also, in this section are other ditto master materials for the subject areas of science, social studies, readiness materials, language, math, and guidance for primary, intermediate, and high school levels.

The third section of the IMC is devoted to filmstrips, loop films, captioned films, and transparencies. To this section belong the Project LIFE filmstrips, which are the most promising programmed materials for the deaf in the areas of perception, thinking skills, and language. The school currently has five sets of the Program Master teaching machine and the seventy filmstrips being field tested in classrooms. Three sets are being used with students aged 5 through 10, and the other two are being used in classrooms for the multiply handicapped with students up to 16 years of age. There are 90 students working with Project LIFE materials, 40 of whom are multiply handicapped.

Each Program Master is set up in an individual learning station composed of a wooden carrel and a rear screen projection system. The school's carpenter constructed five wooden frames which have two openings - one for the Polacoat Lenscreen glass and the other for the Program Master. This arrangement has proved to be most functional since it allows the learner to have close physical contact with both the projected image and the response buttons of the Program Master. This physical closeness allows children as young as five years to use the machine successfully.

Each student is systematically allowed time in these learning stations and can progress at a rate compatible to his learning capacity. Student reaction to these materials has been extremely enthusiastic, and the limited data collected on student performance is quite encouraging.

The fourth section of the IMC is reserved for programs and other individualized materials produced by the school's staff. Because there is a lack of programmed materials published specifically for the hearing impaired student, the school's administration has given several teachers who attended the programming institutes directed by the Southwest Regional Media Center for the Deaf in Las Cruces, New Mexico, released time to develop materials.

One of these programs is a 13 step verb program which teaches four verbs in a sentence context. Each step of the program is contained in a separate manila envelope on which is printed the behavioral objective and the procedures for that particular step. It requires cognitive as well as manipulative skills and can be used with five and six year old children or with the multiply handicapped.

Under contract with Captioned Films fifty sets of this program have been printed and distributed to schools serving the hearing impaired and those with other handicaps. Presently, data is being gathered from those fifty field testing sites for evaluation.

Other individualized materials have been developed for the Grolier Min-Max machine in the areas of language and reading. The language materials are based on transformational principles taught in class; and the reading materials are used in conjunction with the Pacemaker Story Books, (Ferron). These materials provide immediate confirmation for the student so they can be used by the student independently and without the need for the teacher's supervision. They are also used in the dorms as homework assignments.

This year the Oregon School was chosen to be an associate center of the Northwest Special Education Instructional Materials Center at the University of Oregon. As an associate IMC, the school has access to the extensive catalogue of materials at the SEIMC from which teachers can order materials that the school's IMC does not have.

As an associate IMC, the school has the opportunity to use a computer service provided by the State University College at Buffalo, New York. This service enables the school to select behavioral objectives for a particular class or student in a number of subject areas and feed them into the computer which then prints out a comprehensive list of materials most suitable to the ability and interests of each student within a class as well as a set of questions that can be given to the student as a post test evaluating the student's performance within the area described by the objectives. Using the list of materials suggested by the computer, the school can then order from the SEIMC the materials that are available in its inventory.

In order to acquaint future teachers of the deaf with the nature and advantages of programmed instruction, the Oregon School and the graduate program at Oregon College of Education are working in mutual cooperation to teach the graduate students the basic principles of programmed materials. The graduate students first received a short course in the basic principles and terminology of P.I. from a member of the Oregon School's staff. The students were then divided into smaller groups, and each student was required, as part of the graduate program's methods course, to refine one of the programs developed at the last summer institute in programmed instruction at the SWRMCD in Las Cruces, New Mexico. Two of Oregon School's staff members who attended two of the SWRMCD's institutes and have had experience in developing programs work with each student individually as tutor and advisor.

The desired objectives of this program include: a) the preparation of programs in a finished format so that they can be used for developmental testing by the graduate students during their practice teaching; b) the revision of these programs by staff members of the Oregon School based upon the developmental testing data; c) further testing of the revised programs by the teachers at OSSD; d) the incorporation of the successful programs into the curriculum through the IMC; and e) the development of the graduate student's ability to recognize programmed materials and use them to the best advantage.

What has happened so far at the Oregon State School for the Deaf is only a beginning. There are many more goals to be realized, but what has been done has been accomplished because of the foresight, initiative, and complete support of the school's superintendent, Dr. Marvin B. Clatterbuck. Without the igniting spark of the administration, no program, no matter how good, can be long-lived and productive. In any school's program there is a long chain of causality that finally results in benefits for the students, but that chain only begins when the school's administration provides the first link.

Dr. Harry Murphy is Principal of the Southwest School for the Deaf in Lawndale, California. He has a B.S. in Education degree from Temple University in Philadelphia, an M.A. degree from San Fernando Valley State College in Northridge, California, and an Ed.D. degree from the University of Southern California, Los Angeles. His dissertation title was "The Effects of Types of Reinforcement, Color Prompting, and Image Size Upon Programmed Instruction with Deaf Learners."

Dr. Murphy began his educational career as a teacher of normal-hearing students at Camden High School, Camden, New Jersey. He taught deaf children at The Pennsylvania School for the Deaf in Philadelphia. He moved to California in 1966 to accept a scholarship in the Leadership Training Program in the Area of the Deaf at San Fernando Valley State College. Upon completion of that program, he served as a research associate at John Tracy Clinic in Los Angeles for three years. He assumed his present position in August, 1969.

Dr Murphy has published in The Volta Review, The American Annals of the Deaf, and other journals.

The purpose of this publication is to describe activities and interests in programmed instruction at The Southwest School for the Deaf, Lawndale, California. The school is administered and maintained by the Office of the Superintendent of Schools of Los Angeles County and derives its name from its location in the southwest part of the county. Children are accepted on their third birthday. The program continues on several campuses through the twelfth grade. The activities to be described cover the entire 1969-70 school year and the first half of the 1970-71 year.

The educational program is devoted to the individualization of instruction through the use of modern technology. The characteristics of programmed instruction--independent study, continuous interaction with the environment, and feedback--hold special significance for the educational problems of deaf children, first, because a constant visual link with the environment is under the control of the learner, and secondly, because the child may receive linguistic input independently of others and at an individual pace.

A growing body of research evidence indicates that programmed instruction is effective with deaf learners. Consequently, programmed instruction is one of the main pillars in our program of individualization.

We see the technology of programming as a way of thinking as well as being a specific technique. As such it bears a close relationship to many techniques of individualization, to behavioral objectives, to evaluation of instruction, to communications theory, and to systems analysis. The activities to be described below are representative of this point of view.

In-Service Activities. Two workshops in behavioral objectives were held. The first was conducted by Mr. Ellery Adams, Consultant for the Deaf, Los Angeles County Schools. This workshop also dealt with the IPI (Individually Prescribed Instruction) mathematics program. The second workshop, a year later, was conducted by Dr. W. Lloyd Johns, Director of Audio-Visual Services at San Fernando Valley State College. Dr. Johns dealt with objectives and instructional systems.

Dr. Dennis Barnes of the Department of Instructional Technology at the University of Southern California conducted a workshop in programmed instruction (Dr. Barnes is now with the National Technical Institute for the Deaf). Mr. Thomas Robertson, Vice-president of Computer Systems for Education, Palo Alto, California, demonstrated the use of computer-assisted-instruction as a follow-up to Dr. Barnes' presentation. Mr. Robert Lennan of the multi-handicapped unit at the California School for the Deaf at Riverside spoke on evaluation of instruction and shared with our staff many of the programmed materials which were developed by teachers in his educational unit. Mrs. Virginia Fritsch of the Lawndale, California school district spoke on the use of independent learning centers as a technique in individualizing instruction.

This writer demonstrated how to program materials in slide and filmstrip formats, using the Project LIFE teaching machine, the Program Master. Given the sequence of the response plugs and the characteristic symbols of the Project LIFE materials (square, cross, circle, triangle), it is possible to shoot materials with a copystand and a close-up lens on a good camera.

Professional Materials. To give teachers ready-access to professional reference materials dealing with concepts presented during in-service workshops, the following publications were purchased by the school and distributed to each teacher:

(1) Mager, R.F. Preparing Instructional Objectives. Palo Alto: Fearon Publishers, 1962.

(2) Mager, R.F. Developing Attitude Toward Learning. Palo Alto: Fearon Publishers, 1968.

(3) Popham, W.J. The Teacher-Empiricist. (2nd ed.) Los Angeles: Tinnon-Brown, 1970.

In addition, Project LIFE supplied a copy of their Handbook for Teachers to each faculty member. Also, during the 1969-70 school year, each teacher received a subscription to the NSPI Journal which included membership in the National Society for Programmed Instruction.

Instructional Design. As a result of our in-service experiences, the following instructional system was implemented in daily planning and in our curriculum:

1. State objectives in behavioral terms
2. Pre-test
3. Design and implement appropriate strategies to meet stated objectives
4. Post-test
5. Analyze pre-test to post-test data in terms of objectives stated above

6. Conclusion

   (a) Criterion met

   (b) Criterion not met

7. Record data and report to parents

<u>Use of Teaching Machines</u> (Hardware). The first machine to see use in our program was the "E-Z Ed" machine. The machine was made available to us on a loan basis by the Southwest Regional Media Center for the Deaf at Las Cruces, New Mexico. The machine was used with programmed sequences dealing with simple addition and with the making of change. We have these observations to share with you as a result of our experience with the "E-Z Ed" machine: (1) The machine has a light indicating a correct response, a light indicating an incorrect response, and an error counter. The children tended to attend to the two negative reinforcers, so we covered them up with tape. If you have access to this machine, we would recommend that you do the same; (2) The children loved working at the machine, as indicated by pushing and shoving to be first in line to work it, and more dramatically, by the happy faces while so engaged, and, (3) learning occurred.

The obvious love of a child for a "gadget" led us to a number of generalizations which profoundly affected the direction of the program. The first observation was that children are superb technologists. They learn how to operate a television set at about the time they can walk to one, for example. Their toys are sophisticated and technical: The dolls walk and talk and the rockets really fly. The modern home kitchen is literally a memorial to technology. Therefore, we felt that the school should also have a technological orientation. Cameras and projectors were placed in every classroom and in the hands of the children.

The second machine to see use was the Project LIFE Program Master. It was similar to the "E-Z Ed" in that it was a linear, Pressey-type device. It has some unique advantages in that it is lightweight and portable, can handle materials in slide, filmstrip, or motion picture formats, and has an error counter on the back, and consequently out of the sight of the learner.

Instructional Materials (Software). Both commercially-prepared and teacher-made materials are used.

Approximately 40 children between the ages of 6 and 14 were exposed to the Sullivan Reading Series at one time or another during the period covered in this paper. Twenty-one children are currently using this series. In several classes, it is the core reading program, supplemented by experience readings, library books, other reading series, and teacher-made materials. In other cases, Sullivan is supplemental and state texts or other reading series are given emphasis. In one instance, Sullivan is used with two children in a class where the other children are not using Sullivan at all.

The first question we asked was, is Sullivan suitable for our children? The approach is largely phonic, but so are many other reading series. The vocabulary and complexity of language grow quickly, but this is typical also of other series.

We see these advantages to using the Sullivan series:

(1) The series allows one to work independently at an individual rate, (2) immediate reinforcement is built into the series, and (3) the graphics are of high quality and are appealing to children of all ages.

Our experience tells us that a number of prerequisites should be met before Sullivan is introduced to children. The most obvious prerequisite is that the teacher should be trained in its use. A reading consultant was made available to us by McGraw-Hill (distributors of the Sullivan Series) to train teachers in the appropriate use of Sullivan. While this was helpful in giving us a start, teachers feel that a teacher of the deaf who has had experience in using it would be the best resource for training.

The children must meet certain prerequisites. They must have basic independent learning skills (able to attend, sit for a reasonable period, not always needing the attention of the teacher, etc.). Experience in phonics is helpful (it appears that the Northampton Charts lead to good transfer). And, obviously, the language level of the child must be to the point where he is ready to read.

The Sullivan mathematics series was introduced in two classes near the end of 1970. We have no observations to make about its potential with deaf children at this time.

Programs distributed by the Institute for Programmed Teaching (6 East 45th Street, New York, New York) have been used in two junior high classes. The series on studies skills and general science have been used. The language in these series is quite complex (applicable at grade levels 4 through 9) and this has created some problems with the students. However, the students have had a number of opportunities to go through the same program and have come to respond with increasing accuracy on each experience with the program.

The materials made available by Project LIFE, of course, are used. I believe that Project LIFE has made a significant contribution to the education of the deaf in designing and distributing software to the schools. Teachers are also capable of generating their own programmed materials for use with the Project LIFE machine.

Rush's Language of Directions is also being used in two junior high school classes. This appears to be a useful series with deaf children.

We continue to look through commercial sources for appropriate materials. We are optimistic that more and more commercial materials will see use in our program.

At this time, however, and I am sure this is true of most schools, the great bulk of useful programmed materials is generated by the teachers. These home-made programs are time-consuming yet are clearly the most appropriate material for a given group of children when made by that teacher.

Most of the programs made have been paper and pencil, linear formats. Both Skinnerian and Pressey techniques have been used. Paper and pencil programs have been made on beginning numbers, colors, zoo animals, toys, prepositions, opposites, good grooming, learning the names of teachers on campus, and such verbs as, eat, walk, jump, run, swim, sleep, hide, fly, fall, hop, cry, and wave. Programs are used throughout the program, from preschool to senior high school.

A series of speechreading films have been made by a team of three teachers. Children view the films independently, stopping after a stimulus is presented to respond on a reusable answer sheet. This format is similar to that suggested by Stepp (1966).

Computer-assisted-instruction. As noted earlier we have had the opportunity to see a demonstration of computer-assisted-instruction put on by Computer Systems for Education, Palo Alto, California. Many of the large companies (RCA, IBM, XEROX) are very willing to come into a school and demonstrate the use of computer-assisted-instruction. There is no charge for these demonstrations. As an in-service technique, this certainly gets teachers thinking about the future, since the influence of the computer is influencing our lives more and more and will continue to do so in the area of education.

We are to the point where one major company will loan us a computer for experimental use from time to time. We have used it enough to confirm the fact that children learn very effectively from a computer. Motivation is extremely high and again, this reinforces our belief that giving a child a gadget has a positive influence on his learning.

The Learning Wall. Three and four year old children are introduced to programmed materials via "The Learning Wall", an interactive rear-screen device.[1] Programmed filmstrips are rear-projected onto

[1] "The Learning Wall" was developed under Project ME (Media for the Exceptional), Dubnoff School, North Hollywood, California. Project ME is supported by Media Services and Captioned Films for the Deaf.

the screen. The children are encouraged to discriminate from among alternatives by touching the right answer on the screen ("Show me the baby"). Confirmation comes as the next frame is projected onto the screen (the projector is triggered by a teacher who manipulates the remote control device). Such pre-conditioning leads to good transfer when children are assigned to the Program Master. The Learning Wall also allows us to put Project LIFE programmed materials in the hands of a greater number of teachers and children.

Other Interests in Programmed Instruction. Dr. Leo Persselin of TRW (El Segundo, California) has conducted field testing on our campus with children as young as 13 years old, training them through programmed instruction to do electronic assembly under a contract with Media Services and Captioned Films. We cooperated with Dr. Persselin while he was revising one unit and discovered that our 13 year old students, through programming, adequately carried out some extremely complex electronic wiring.

We hope to increase and improve our use of programmed instruction by (1) providing continuous in-service, (2) consistently reviewing commercial materials to determine if they are suitable, and (3) by integrating our curriculum and library of programmed materials to see that the best use is made of any given sequence, with the right child, at the right time.

Peter Pipe, senior associate, Pipe & Associates, is a consultant, teacher, editor, and author in the field of instructional technology. He has conducted many workshops on programmed instruction and on planning and performance objectives for schools and companies and has been a part-time faculty member at San Francisco State College.

Mr. Pipe is author of "Practical Programming," published by Holt, Rinehart & Winston in 1966 and is co-author with Robert F. Mager of "Analyzing Performance Problems," published by Fearon Publishers in the Fall of 1970. Mr. Pipe is author or co-author of some 30 self-instructional programs and courses and he has been responsible for the production of some 30 others in a wide range of subject matters.

In recent years, much of Mr. Pipe's work has been in the health sciences. His current work includes an appointment as consultant and head of materials production in a federally-funded project at the University of California School of Dentistry for self-instructional continuing education for dentists. He is also a consultant to the American Dental Hygienists' Association subcommittee which is developing performance objectives for a guideline curriculum in dental hygiene. In the past year, he has four times served as a faculty member in PPBS workshops conducted by the American Academy for School Executives for superintendents and other top school administrators.

Some days it isn't easy to be a believer in programmed instruction. You look at someone else's latest offering and you think, "How dull!" Or "I'd hate to have to learn from a program." If it is true that the purpose of any learning experience is that it should serve us in the future, then any program which even tarnishes the learner's desire to stay in contact with the subject matter has to be rated unsuccessful. It has failed in what may be the most important dimension of all.

Many forces conspire to make programs less effective than they might be. A major one is society's accelerating rate of change. It's hard to solve a problem when the problem and the available solutions are continually shifting. This is as true in education and in the tiny facet called programmed instruction as it is in most aspects of life. The ideas of ten years ago may be obsolescent; those of twenty years ago may be as dead as the dodo. In the teaching profession, which still has some reverence for "the literature," this can be intensely frustrating.

For a perspective of the changes in programmed instruction, one can set the year 1960 as a benchmark. Sidney Pressey's work predated this by nearly forty years and B.F. Skinner's contribution preceded it by a couple of decades, but it was only in 1960 that programmed instruction came to public attention under the banner of the Teaching Machine Revolution. From that point one can trace distinct phases of development and see that many early concerns now have a much lower priority.

If we start at 1960, it is convenient to identify two major schools of thought about programmed instruction: Skinner's so-called "linear programming" and Norman Crowder's "branching programming." Many people gained academic credit by comparing the two. Most studies were inadequate and, it has been said, the results typically showed "no significant difference" or they were contradictory. The two schools of thought are more interesting from my point of view not in terms of format or merit but for the fact that they represent two totally different philosophies as to what instruction is about. Perhaps its a little glib, but it seems to me that Skinner's disciples, in their efforts to shape student behavior, were more concerned with a science of learning.[1] Crowder, by contrast, insisted that in the absence of a true model of learning, his concern was with communication; he wanted to get the message through in as interesting a fashion as possible, and hence might be said to be concerned with the art of teaching. The two approaches were similar in two strange ways. Each emphasized and had its antecedants in the use of devices - teaching machines - for presenting instruction, and each seems to have assumed initially that the preparation of instruction was simple enough that there was little need of rules or procedures for programming. While Thomas Gilbert tried to remedy this deficiency by laying the foundation of a technology of instruction,[2] making a good deal of sense if you took time to tease out the message, his approach was not widely adopted. The emphasis - the thinking and the sales effort - at that time and indeed for the next two or three years was on teaching machines rather than on programmed instruction. The teaching machine was to be a panacea for all that ailed instruction and ingenious salesmen succeeded in moving a fairly large number of teaching machines of varying complexity. Eventually, though, there came a reappraisal. Even when the machines worked there were, it seemed, deficiences in the materials. Customers came to realize what had become apparent to those of us who were trying to write programs: One cannot simply stuff a conventional textbook into a teaching machine and expect instant miracles. Programmed instruction was ready for its next stage of growth.

At that point, one could look back and conclude that in many, perhaps most cases, the hardware (the machine) was less important than the software (the learning materials going into the machine). Schramm,[3] looking back over the scene, commented to the effect that Skinner's great contribution had been to build a bridge between behavioral science and education along which practitioners of each could travel to the other's country. This new approach, by ensuring that a group of students were all subjected to the same learning experience, made it easier to control one of the variables in a learning study. Results showed self instruction was as useful as a teacher for causing certain kinds of learning to occur. Not so well documented but nevertheless important in my opinion, programmed instruction provided for some students the first successful learning experience of their school careers. At this time too, there seemed to be some merit in the claim that programmed instruction somehow or other saved time - a figure of 30 per cent was often bandied around.

As ever, there was in this reputed time-saving no miracle. What was happening was that in writing a program, the programmer-teacher confined himself to the issues at hand instead of throwing in peripheral or even irrelevant information as can happen with the best of teachers when their egos are properly manipulated by students.

In this apparent time-saving lay the clue to the next step forward. As you must have found if you have tried to write a program, if you plunge with too little preparation, you soon find it necessary to back up and begin to think about your destination. If you have been properly vaccinated with instructional technology, you will ask, "What must my student do to demonstrate that he is competent?" At the time I am speaking of - 1962 or so - this question was not so obvious as it now seems. It was at this point that Mager made a timely entry with his book on objectives.[4] His message was short and simple but as his introductory fable says, "If you're not sure where you're going, you're likely to end up someplace else - and not even know it." This small book has been, I submit, one of the great contributions to instructional technology. It wedged open the door to the thought that the true outcome of instruction is a change in student performance and that this performance is measurable. It gave new weight to the argument that programmed instruction can often come closer than conventional instruction to guaranteeing certain changes in student performance. I hastily add that there is still no miracle involved. In developing a program, one can do more than bring to bear the talents of a solitary classroom teacher; instead, one can call on the talents of a whole team of people - subject matter experts, teachers, writers, artists, even students - and then one can expose their combined efforts to learners and continually refine the materials to the point where one can predict a strong probability of success.

Perhaps you noticed that I added yet another dimension to programming in that last statement. Programs are not completed at the first writing. Their development includes (or should include) a process of developmental testing and revision. If testing shows that a program does not achieve its stated purpose for its stated audience then more work must be done.

To look at the other side of the ledger for a moment, one must admit that programmed instruction also had a lot going against it at that time. If many programs, particularly the early linear programs, have one attribute in common, it is that they are deadly dull. Another problem concerned the choice of subject matter. The post-Sputnik era put heavy emphasis on mathematics and science. It was unfortunate that much time and trouble went into preparing a mathematics curriculum that was about to be superceded by a "new math." Yet another problem was that many early programs were rushed to the market place before anybody had checked that they would work. So programmed instruction quickly had three strikes against it - dull, irrelevant, inefficient - and the whole movement came close to getting dropped from the league. Paradoxically, one of the great strengths of programmed instruction also became apparent. In conventional instruction, if a course dies and the student fails, it's hard to tell what is wrong since the instructor's words have all vanished into air. When a program dies, the corpse remains and an autopsy is possible. When you perform the post-mortem, you may find yourself asking not only "Why did it fail?" but, with a broader perspective, "Why did I want him to do this? Of what future performance is this a part?" Those questions answered, you may ask, "What is the best way of getting my student to this level of achievement?" When you have identified and produced this process - and it may not be programmed instruction of a familiar sort - you can ask, "Did I succeed?" And if you did not, "How must I change the product (i.e., the student) or the process in order to succeed?"

In the foregoing we have the shift from programmed instruction to the broader perspective of an instructional technology. Before we pursue this technology any further, a note of caution: "Technology" has about it a suggestion of stainless steel, of things mechanical, well designed, and superbly efficient. This is not such a technology. This is a system of approximation, a means of getting better as we go along by evaluating and refining. I question that anybody can become perfect at this. I doubt that it even matters whether we are perfect. Education sets its sights on the future, a shifting target in this world of accelerating change. Our problem is one of keeping up, of getting better, rather than one of being perfect.

To get back to the argument, our early concerns with programs that shape behavior or ensure communication have grown into a larger technology in which we have to:

--Specify measurable outcomes for instruction;

--Ensure that the outcomes are relevant in the larger context of the student's future;

--Identify efficient processes for attaining those outcomes;

--Use feedback to amend both the outcomes and the processes where experience shows them to be deficient.

If we are no longer confining ourselves to programs of a familiar format, what is an "efficient process"? The question has implications about the way in which the teacher fits into instructional technology. I believe that for many teachers it suggests a role more demanding and more relevant than the actual writing of programmed materials.

Suppose that you as a teacher decide that your student must be able to read at some specified grade level. This decision about your goal can readily be turned into a performance objective along the lines of:

> Given thus-and-such a standardized test, the student will be able to read at such-and-such a grade level.

With that as a terminal objective, one could determine subordinate objectives and critical incidents, and then write criterion items for each important objective. Is it time to start writing a program? I'd say not. What I earlier called "the most important dimension of all" has been neglected.

If reading is a meaningful skill for application in a future of lifelong learning, then not only must your student be able to read but he must like to read. And the latter, I suggest, is the more important. Most of us need only reach back into our own schooling to concede that it is possible to make a person competent in some subject matter and at the same time teach him to hate it. Looking at it in the larger context, if competence plus hate are the outcomes, it has not been a successful learning experience. For success, one needs an affective outcome, a favorable attitude, a willingness, in this instance, to come into contact with reading.

Attitude has been defined as: A tendency to respond in a characteristic way, either positively or negatively, in the presence of some social cue such as an institution, a person, a situation, an idea, or a concept. An attitude, then, is a tendency to respond in certain predictable ways.

We can change the probability that a response will recur by controlling the consequences of that response. At the simplest level, if we want to increase the probability of a response, we provide a favorable consequence as a result of responding; to decrease the probability of a response we provide a consequence that is other than favorable. One can build a much more telling argument than this, but I hope that you will be willing to leap along with me to the thought that if we wish a student to have a favorable attitude towards the subject matter, then there must be a favorable consequence linked to his contact with it.

Hazards await the teacher who decides to provide "favorable consequences." First there is the trap of thinking that consequences perceived as favorable by the teacher are necessarily so perceived by the student.[5] For example, a teacher may lavish praise on a student for work well done. But the child, subjected to the judgment of his peers that he is a "brain" or "teacher's pet," may perceive the teacher's approval as distinctly punishing. A more difficult problem to spot is that posed when student effort is followed by no consequence. Providing no consequence is a classic way of extinguishing behavior. (Note again, please, that this is "no consequence" <u>as perceived by the student</u>. It is possible for a teacher to provide a consequence which has no value to the student.)

Then there is the further trap of assuming favorable attitudes are directly related to subject matter. If, say, we wish a child to enjoy reading, then we must beware of assuming that because a small amount of reading leads to some favorable attitude, a lot of reading will lead to a lot of favorable attitude. We get favorable attitudes by providing processes with favorable consequences and not by burying the child in subject matter.

The foregoing has implications when you prepare a program intended to cause learning to happen. It may not be enough - and usually, I suggest, it is not enough - simply to shape the student's competence through a series of successive approximations or to ensure that your message communicates with crystal clarity. The true problem is to provide experiences that will make the student feel that what he has done is challenging, satisfying, relevant to life as he perceives it, even "fun."

Speeth and Margulies have interesting suggestions about how to maintain student motivation.[6] They present some ten techniques for making programs more interesting. Brutally capsulized, they say:

> Keep your examples in the student's context so that you deal with issues and objects that are part of his world;
>
> Change the pace on him so that he doesn't know exactly what is coming next;
>
> Challenge him by making him use previous information rather than simply working with a single concept.

You may care to think too, about the implications of behavior modification for shaping what happens both within your program and the way you fit it into the curriculum.

In a nutshell, what I am advocating is that a programmer should be as much concerned with the affective as he is with the cognitive and psychomotor. I am also saying that in my opinion the affective has had short shrift until now, both in the literature and in practice. And if that is true, then teachers who are trying to structure precise learning experiences according to the precepts set out in the literature may not be making good use of their time. Rather than trying to capture words on paper, an activity in which most do not excel, they would do better to operate from strength, making use of their knowledge of what "turns on" their students.

Given that, we can then turn attention to the new dimension, the affective dimension, and produce a new generation of programs, unfamiliar in format and technique but a joy for students to use. At that point, the use of a program may become an intriguing, rewarding challenge, and learning will be what it should be, a demand-creating experience.

REFERENCES

1. For example, Skinner, B. F. The science of learning and the art of teaching, Harvard Educational Review, 24/2, 1954.

2. Gilbert, T. F. Mathetics, the technology of education, Journal of Mathetics, I/1, Jan., 1962; I/2, April, 1962.

3. Schramm, W. Programmed Instruction Today and Tomorrow, Fund for the Advancement of Education, 1962.

4. Mager, R. F. Preparing Objectives for Programmed Instruction, Fearon Publishers, Palo Alto, 1962.

5. See, for example, Mager, R. F. and Pipe, P., Analyzing Performance Problems, Fearon Publishers, Belmont, 1970.

6. Speeth, K., and Margulies, S., Techniques for maintaining student motivation, NSPI Journal, VIII/3, March 1969.

Elaine Costello is the Instructional Programmer in the Media Services and Captioned Films sponsored Project for Individualizing Instruction for the Deaf at Callier Hearing and Speech Center, Dallas, Texas. Prior to her present position, Mrs. Costello taught the deaf for seven years: two years at the Lutheran School for the Deaf, Detroit, Michigan; two years in the Dallas County-Wide Day School; and three years in the classroom at Callier.

Mrs. Costello has a M.S. from the University of Kansas and a B.S. from Central Institute for the Deaf, St. Louis, Missouri. She was a participant in a N.D.E.A. Reading Institute in Kansas City in the summer of 1966 and was a demonstration teacher for a Reading Institute sponsored by Callier and S.M.U. in the summer of 1968. She received her training in programming at the Summer Institute in Programming and Instructional Systems at the Southwest Regional Media Center at Las Cruces in the summer of 1970.

Accompanying rapid development in any field is the lag between beginning use of the terminology and a common interpretation of those terms. We feel that this same problem has attended the growth of modern educational technology. Through our experience in the Project for Individualizing Instruction for the Deaf at Callier Hearing and Speech Center, we have identified certain popular expressions that seem to be interpreted inconsistently across the field of education. Those that appear pertinent to the subject of this discussion include programmed teaching, programmed instruction, individualized instruction and programmed learning.

The brief definitions that follow are our own and will be developed at greater length throughout the text of this paper.

PROGRAMMED TEACHING AND PROGRAMMED INSTRUCTION:

Programmed teaching seems to imply systematic organization of what the teacher does, not necessarily dependent upon any reciprocal action or response from the learner. Programmed instruction, however, often is interpreted to include materials, and the term "instruction" suggests an interaction involving instructor or materials and a student. The instructor in this case could be a professional teacher, tutor (non-professional or another student), or a machine.

PROGRAMMED LEARNING AND INDIVIDUALIZED INSTRUCTION:

The definition of both of these terms describes a systematic ordering of the curriculum. To us, the curriculum is what happens at school. It is not a guide <u>to</u> nor a collection <u>of</u>

materials; rather, it involves all of the elements of the educational system.

Programmed learning or individualized instruction requires that each of the elements of the system be analyzed, the alternatives identified, and that the appropriate alternatives be selected and matched with the diagnosed needs of individual pupils.

The design on the following page (Figure 1) was developed in our project as a means of focusing on the elements that appear basic to the development of systems of models and the relationship of these parts to the process aspect of the educational system. It describes a learning setting...the child as an interacting entity (the open lines surrounding "the child" are intended to convey interaction with the environment), factors in his entering behavior, and elements in his environment with which he interacts. The process from left to right indicates that the result of the interaction with the system is some modification of his behavior.

In programmed learning the emphasis is placed upon the individual student. This does not mean that there is one teacher for each child, nor does it mean that each child works only independently. Quite the contrary, programmed learning provides for greatly diversified abilities in a group within the same classroom, and yet, each child is served at his level, in the manner in which he learns best and which allows for his particular abilities.

THE LEARNER IN THE INSTRUCTIONAL SYSTEM

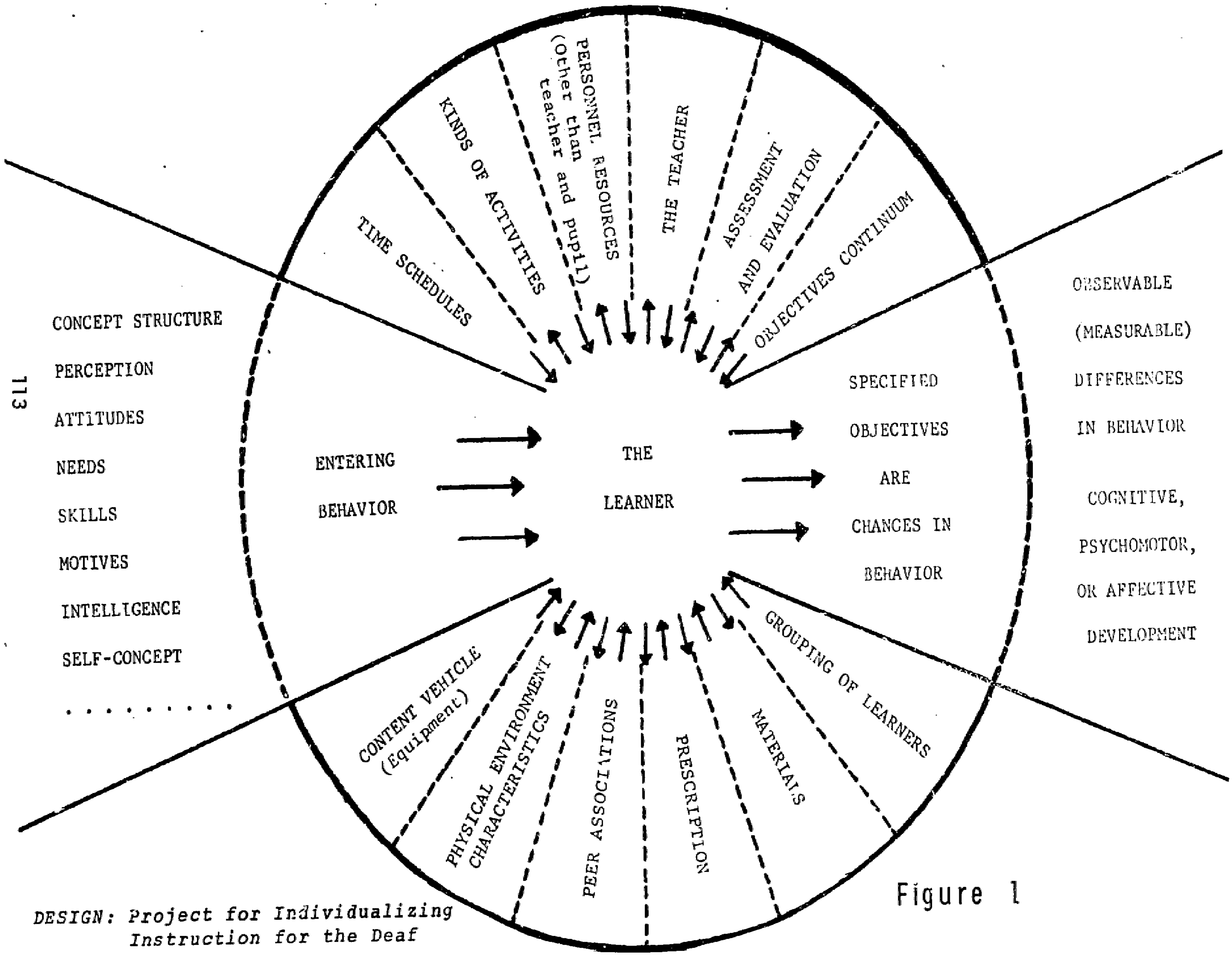


Figure 1

DESIGN: Project for Individualizing Instruction for the Deaf

Callier Hearing and Speech Center, Dallas, Texas

Our project is contracted under Media Services and Captioned Films for a proposed five years. We are at this time midway through the second year. The project is moving forward under the leadership of the Project Director, Carl Nordwall. It is in response to his enthusiastic direction that innovations are taking place in our classrooms.

We had a head start when the project began, in that many of the changes that are necessary in most institutions were already build in at Callier, for instance, the physical facilities, production capabilities and media resources. Our main concerns have been in two areas: (1) in-service training of teachers, primarily in the area of philosophies of individualized instruction; (2) describing and defining the elements of the curriculum so that we have a systematic organization of alternatives.

In our weekly in-service meetings we have spent time learning to develop behavioral objectives. One positive change in teacher behavior was their recognition of the necessity of writing lesson plans with a smaller unit approach defined by behavioral objectives. Other areas of emphasis in our meetings have been pupil scheduling options, systems design, pupil contracts, behavior modification, programming techniques and utilization, and equipment designed for independent study. The most recent meetings have involved teacher reports of visitations to other programs utilizing programmed learning techniques.

In our interpretation, the learning system begins with diagnosis. Typically, schools administer achievement tests, psychologicals, and various other instruments that could be pulled together to provide a useful diagnostic profile. We feel that this is almost never done systematically; however, through design of new instruments and more appropriate use of those currently available, we are working toward the refinement of the diagnostic element of our system. Almost a year ago we employed a consultant in psychology who, with the active participation of the teachers, produced an observation-recording instrument. Constructs were selected that describe the child in terms of his independence, motivations, etc. The teacher periodically completes each student's profile on the basis of her observations and modifies her teaching strategies, materials, and schedules appropriate to that profile.

There are twenty-seven teachers in Callier's Educational Division. Although only nine of these are project members, we have twenty or more teachers and administrators come to the project meetings voluntarily each week. Seven of the project teachers are in grades one to six, while the other two are at the kindergarten level. Each year the project plans to involve more teachers and younger children. Teachers may join upon invitation as defined by our contract. All project teachers are involved in a continuing in-service training program. New project teachers receive initial training through a programmed course in instructional technology which involves self-instructional audio tapes, filmstrips and workbooks.

At Callier we have found that there are certain conditions of the curriculum that are logically prerequisite to programmed learning. Team planning and team teaching, flexible groupings, scheduling and non-gradedness provide the framework within which we organize programmed learning. The older students often are involved in independent study contracts which may or may not be coupled with contingencies. Behavior modification techniques are used, sometimes with group behaviors and sometimes individually. Programmed materials are developed upon teacher request and are used by the children independently or, in the case of preschool children, with the aid of teacher assistants.

The teachers at Callier have a wide variety of media equipment available to them, both in the classrooms and in central production facilities. A teaching console in each classroom provides for simultaneous multi-media presentations. It contains an overhead projector, tape recorder, auditory training equipment, switching and complete remote controls for slide, filmstrip, and 16mm projectors, and rear projection systems for the filmstrip and slide projectors. Reading equipment, which the children use independently for physiological eye training, includes tachtisoscopes and controlled readers. Various machines for programmed materials and independent study materials are also available in the classrooms. Multi-media study carrels are conveniently located for independent study. Some of this equipment has been developed by the Communication-Media Department and Electro-Mechanical Department at Callier with designs that support the project theory and in the interest of project concepts. One machine designed by project personnel has produced the one program device which is flexible enough to accommodate any programmed materials involving multiple choice responses and up to 180 frames. It allows for easy rearrangement of response sequence as necessary in developmental testing and revisions of original programs. This machine also emits a tape response recording which provides a permanent charting of how each child responded to each frame on the program.

Additional emphasis in our project include reviewing and selecting commercially available programs and developing additional programmed instruction materials. We have identified very few commercially produced programs that are appropriate for a deaf population.

Another source of programs are those that are developed at the summer institutes at the Southwest Regional Media Center in Las Cruces, New Mexico. We reproduce these in a usable format and often revise them as indicated by our needs. We have also received some programs from other schools for the deaf and we cooperate in validation testing the programs for them.

Any additional programs that the teachers request we develop in our Project Office. We have a full-time artist and secretary to facilitate production. We have approximately two hundred programs in our materials component. Our secretary is currently cross-cataloging the materials by format, level, and subject.

We are interested in increasing communication among schools and agencies who are producing and using programmed materials. We are cooperating with the Southwest Regional Media Center in their function as a clearinghouse for dissemination of programs, and are concerned about identifying means of reproducing our programs in a usable format and in quantity for circulation to interested schools. By designing an objectives continuum, primarily in the area of language, and then focusing our programming efforts to a unit approach based on these objectives, we feel that we would be contributing to a vital area which would be of importance to other schools for the deaf.

In summary, our experience has shown us that implementing programmed learning in the classroom initially involves in-service preparation for administrators, then for teachers, and finally, an on-going in-service program allowing for an interchange of problems or new ideas. We have found that the visitation trips to other schools or projects that each project teacher is allowed to take have not only inspired enthusiasm, but also have been a vital source of ideas from which the teachers can design their teaching strategies.

Helen Ross Sewell attended the School for the Deaf at Berkeley, California, for two and one-half years prior to entering Gallaudet. She was graduated in 1948 with a B.A. degree. The years between her graduation and 1958 were spent in traveling around the United States and working at a variety of positions from typist-file clerk to electronics assembly. After one year as a counselor of small boys at the New Mexico School for the Deaf, she took a teaching position at the Texas School for the Deaf in Austin where she works today.

Mrs. Sewell specialized in teaching communication skills to slow-learning children. She became interested in programmed instruction when introduced to it at an in-service workshop. She attended the Institutes in Programmed Instruction at Las Cruces in 1969 and 1970. During the school year between the two summer institutes, she wrote programs part-time and taught in the junior high school department part-time. She is now spending all her time writing programs and is especially interested in developing materials for use in primary grades.

Objectives: To develop communication skills for self-expression and comprehension.

These objectives were presented to 14-16 year old slow learning students in a series of questions which were discussed in class, such as: If you get sick, how will you tell the doctor what is wrong with you? If you want some shoes repaired, how will you find out the cost so you can decide if it will be worth the money? If you smell gas in your house and can't find where it is coming from, how will you ask someone to call the gas company to come and investigate? If you want to visit a friend who lives far away, how will you tell him and find out if he will be home that day?

Most of the children had not previously seen communication skills in this self-centered light and it provided motivation for a greater degree of effort than they might otherwise have put into the program. Reminders of these "selfish" motives, sometimes subtle and sometimes sledgehammer type, were given frequently through the year.

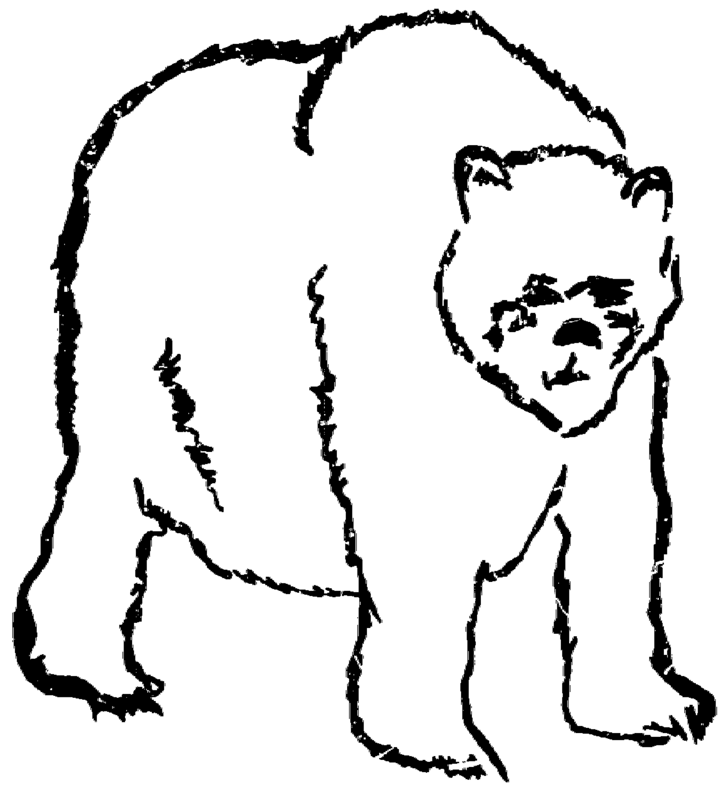
A MIVR set-up similar to the one illustrated in Fig. 10 in Dr. Raymond Wyman's article in the November, 1969, issue of the Annals was used. There were ten projectors on two sides of the room and one for the teacher at a point where all the students could see the screen. At first, screens for the students' projectors were wide strips of paper but these were inclined to come down in the slightest breeze and were replaced by cloth, which proved much more serviceable. Our Media Center made transparencies for vocabulary from the CID

Language Outline printed in the American Annals of the Deaf, September, 1950, and these were used for a base for teaching two classes. One of these classes progressed through all of the nouns on the first three levels and the verbs on the first two. The other class was able to assimilate most of the first level nouns and verbs and part of the second level nouns.

A typical transparency for a noun (Figure 1) had a simple outline picture, the noun as a title and five to seven short sentences using the noun in singular or plural form. The last sentence left a blank in place of the noun being taught.

With only the picture exposed, each child was asked to fingerspell the name of the object or animal. The next step was to expose the title and each child would fingerspell it. We would then spend a few minutes discussing the item, bringing out whatever the children knew about it. The first sentence on the transparency was exposed and one child would translate it to manual communication. Succeeding sentences were "read aloud" by other students in turn. If any doubts arose as to their comprehension--such as when they fingerspelled a word for which there is a common manual symbol--they were asked to explain in other words what it meant. Soon they began to ask for definitions before they began to translate. In the last step, all the language on the transparency was blocked out, the last sentence exposed and the children were asked to write the noun on their overhead projectors, show their responses to the teacher, compare them to the original and correct themselves if necessary.

Figure 1.



A bear is an animal.

Bears are big.

Bears sleep all winter.

This is a ________.

Immediate reinforcement was supplied by showing, one at a time, a variety of pictures illustrating the noun and asking them to write a sentence. Each child, as his sentence was completed, showed it to the teacher and received confirmation or directions for correcting. The students were required to compare their sentences with those of others in the class. Copying before receiving confirmation died a swift natural death after a few had crossed out correct sentences and copied erroneous ones. At first all the sentences tended to be repetitions of those on the transparency. Very gradually, a little diversity crept in and it developed that the best reinforcement for this and encouragement for originality was being pointed out to others as an example. We spent as much time as was needed on each word to insure a measure of success for each child, success being a sentence that did not have to be corrected in any way.

Simple riddles were an exercise the children came to like and were helpful in review as a change of pace from the drill of writing the nouns for the pictures. Another popular reinforcement activity was to choose teams and take turns fingerspelling the name of the projected picture. Competition in these games was high pitched and the children began to drill each other outside the classroom. Filmstrips, movies and TV shows were used as enrichment materials wherever they fit in.

Verbs were taught in much the same way, with a sequence of three pictures and sentences on the transparency (Figure 2), showing the future, present progressive and past tense forms of the verb. The student were asked to write the three verb forms after reading and talking about

Figure 2.

She will have a party. — She is having a party. — She had a party.

1. She ____ a party.

2. She ____ a party.

3. She ____ a party.

the sentences. Then a variety of pictures was presented, showing as many different meanings of the verb as possible, and they were asked to write sentences using the verb in a given tense.

Question forms were taught by using a series of teacher-made transparencies. These could be duplicated for student response in the absence of a MIVR set-up.

For the two classes whose communication skills were more highly developed, the Language Arts Transparencies prepared by the NERMCD were invaluable aids. The LAT were used to present the language principle, pictures from other sources were used for additional practice and finally, they were led to apply it to themselves and their own experiences and activities. One of these classes completed the LAT series, reviewed parts of it and went on to more advanced sentence structure. The other class did not quite complete the LAT program.

Part of the initial success of using this method and the MIVR set-up can be attributed to the children's fascination with using the overhead projectors. By the time the novelty wore off, they had learned to like receiving immediate confirmation or correction of their attempts at written communication.

Evaluation: During the first three months, careful records were kept of vocabulary scores. These showed an average weekly gain of 80% or better for each child. At the end of three months, the recall test of 20 nouns selected at random from 50 that had been presented, averaged 60%. After this, the learning pace accelerated and the records deteriorated as more time was spent collecting and co-ordinating teaching materials.

Comparison of the first letters written home in the fall and the last letters written before summer vacation was made. From time to time, original stories based on a picture or cartoon were compared with previous work. These were evaluated for the individual, not the class as a whole. The improvement in sentence structure, wider range of vocabulary, ability and willingness to express abstruct ideas as well as concrete facts, were quite noticeable.

In the area of independent learning experiences, programs are being developed with special attention given to the primary level. These programs so far are paper and pencil type but we have plans for developing film strips that can be used individually or as a group learning activity. We are also developing videotaped stories to encourage reading. The stories are made available to the children in printed form. The last part of the videotape is a programmed exercise which requires the children to make responses on paper. Without the exercise, the stories are used as cultural enrichment.

Mrs. Joan Tellam received her B.A. in Special Education from the University of Arizona in 1959. Immediately following her graduation she became a teacher in the primary department of the Arizona School for the Deaf where she is still employed. She has also completed a Masters Degree in Elementary Education at the University of Arizona in 1970.

Mrs. Tellam was a participant in both the Beginning and Advanced Institutes on Programmed Instruction at the Southwest Regional Media Center for the Deaf. She has used techniques of programming to improve classroom instruction procedures and hopes eventually to become a full-time programmer.

It is the purpose of this paper to discuss certain characteristics of programmed instruction and its use in programming for young deaf children. The author's reference to young deaf children means children who are prelingually deaf and whose reading ability is limited to word-picture association.

Of the following list of characteristics of programmed instruction, some are characteristic of an entire program, while others are characteristic of individual frames: (1) Behavioral objectives, (2) Directions for method of response, (3) Pre-test, (4) Hierarchic presentation, (5) Confirmation, (6) Reinforcement, and (7) Post-test. For our purpose here, there will be considered some characteristics of the program which the author has developed to use with young deaf children.

The first characteristic mentioned is also the first consideration when preparing a program--the behavioral objective. The programmer must determine what it is the program will teach and how the child will demonstrate his acquired knowledge.

The determination of the behavioral objective thus should lead the programmer to the next area to be considered--the response modes. If the objective calls for recognition and selection of the correct answer, then multiple-choice items requiring the same behavior are appropriate. If, however, the objective requires the child to recall and construct an answer, then the program should provide for that type of behavior. Directions to the learner as to how to respond normally are given in individual frames. However, the author has found that when more than two response modes are used in a program, the young child becomes too preoccupied with deciding what he is to do. Therefore, the author prefers to limit the number of different response modes per program and to give directions previous to the pre-test. These directions may be demonstrated to the child in a series of "practice frames" which will set the pattern of behavior desired.

In order to determine the instructional value of a program, it is necessary to administer a pre-test. This test should be administered after the response mode patterns are established. This eliminates the possibility of the child making errors because he does not know how to respond. The pre-test should measure all aspects of what the child is expected to achieve through the program. For example, if the hierarchic presentation calls for picture matching, word matching and word-picture association, sentence matching and sentence-picture association, then all these aspects should be pre-tested. The author has found that when administering pre-tests, it is best not to give the child knowledge of his results. When the young child consistently makes errors, he often becomes so discouraged he is afraid to approach the program. Or, he quits before the pre-test is completed. It is far better to keep encouraging him to proceed the best he can.

Another characteristic of programmed instruction is the hierarchic presentation. This has been a relatively natural method of presentation, since it is almost identical to the steps taken by any teacher of young children -- that of starting the child with very simple tasks which he may already have mastered and leading him to the next most difficult, and the next, and the next. The author's experience has been limited to simple linear programs. The directions required in a branching program would be an impossible task for children with such limited language.

Confirmation is a very important characteristic of programmed instruction, thus giving the child knowledge of the results of his progress. This, for the most part, should be confirmation that his response was correct. It is this feature of programmed instruction that encourages the child and keeps him progressing through the program. It is very important that the child be able to compare his response with the correct answer. The technique of placing a frame on one side of a card and its answer on the back has not been successful for the author. This does not provide for easy comparison of response and correct answer.

When fine discrimination is required, it is easy for a child to make an error, flip the card over, look at the answer, and think he is right. The author has found it is necessary to have the confirmation covered but on the same side of the card for paper-and-pencil programs. For a programmed series of slides the confirmation should come by comparing the child's answer on an answer sheet with confirmation slide. When fine discrimination is required, it may be necessary to go one step farther to assure correct comparison. Each choice the child has to select from may be cued with the use of position, color, or a different symbol preceding or following each choice. When position is used, it is necessary that all the choices available be repeated in the confirmation and the correct one circled or underlined. When color is used, each choice can be written in a different color. For confirmation, the correct answer should be written in the same color as it is in the frame. When symbols are used, the same symbol should accompany the correct answer in the confirmation.

The continued success and newly-gained independence of the child are usually all the reinforcement necessary to keep children working at a program. However, a little extrinsic reinforcement may lead to better retention. For example, if the child is able to spell a word at the end of a program, but cannot spell it the next day, he can be encouraged to retain it if there is some small extrinsic reward. He will learn a word a day and spell five words correctly on Friday if he is rewarded with a piece of candy on Friday.

The post-test should parallel the pre-test, but not necessarily be identical. If identical examples are used on pre- and post-tests, there is a probability that the child may remember the response he gave on the pre-test and repeat it on the post-test even if it is a wrong response. The author has found no reason why knowledge of results on the post-test should not be given to the child. In fact, it is often very encouraging to the child to know of his successes in the post-test.

It is a well-known fact that preparation of programmed instruction materials takes a great deal of time. It can easily take the programmer six times as long to write the initial version of a program as it takes her subjects to complete it. Then there is revision time and re-testing time.

Since the author's preparation time is extremely limited, attempts have been made to prepare some group instruction programs. Actually, what this amounts to is employing as many characteristics of programmed instruction as possible in a group instruction process. In this process, it is still necessary to first determine the behavioral objectives -- in this case for all the children to achieve certain specified behaviors. The difference in this type of group instruction and the type most of us are familiar with is that each and every child is required to make an overt response each time, either in an answer booklet or on an answer sheet. The hierarchic presentation of programmed instruction is still retained. Confirmation is given. Each child compares his answer with the correct answer before moving on. The greatest detriment to this type of instruction is the fact that the child does not progress at his own rate, but must wait for others to make their choices and confirm their answers. It is also important that the responses remain private to the individual. If the response of one child is available to any others, the others may not make their own decisions. Although this type of presentation has certain undesirable characteristics, the author feels that it is an improvement over other methods of group instruction. It should be used only when idividualized instruction materials to meet children's needs are unavailable.

This type of presentation can be effectively used to improve instruction when viewing movies or filmstrips. The active participation and overt responses from each and every child is an improvement over inactive viewing and covert responding.

Dr. Patrick Suppes' vita is almost endless. At Stanford University alone he has been an instructor (1950-52); Assistant and Associate Professor, Department of Philosophy (1952-59); Associate Dean School of Humanities and Sciences (1958-61) and since 1959 to the present has served a dual role in the Department of Philosophy as Professor of Philosophy and Statistics and Professor of Philosophy, Statistics and Education, plus he is the Director of the Institute for Mathematical Studies in the Social Sciences. Between 1963-69, Dr. Suppes was the Chairman of the Department of Philosophy.

Since Dr. Suppes obtained his Ph.D. from Columbia University in 1950, he has been the recipient of numerous fellowships and awards. He has been a Fellow with the Center for Advanced Study in the Behavioral Sciences, the American Association for Advancement of Science, the American Psychological Association, and the American Academy of Arts and Sciences. Some of his distinctions include the Nicholas Murray Butler Media in Silver (Columbia University), the Palmer O. Johnson Memorial Award (American Educational Research Association) and the John Smyth Memorial Lecturer (Victorian Institute of Educational Research, Melbourne, Australia).

Dr. Suppes holds membership in some twenty professional societies. He has authored some nine books with the two most recent being Studies in the Methodology and Foundations of Science and A Probabilistic Theory of Causality. Dr. Suppes has also edited seven books and penned some 105 articles. Additionally he has written over 30 elementary mathematics textbooks and popular articles.

"How did a professor of philosophy become involved in computer-assisted instruction?" A good place to begin is with an answer to this question asked by George Propp. As is appropriate to philosophy, the answer is a little devious.

I became interested in mathematics curriculum at the elementary-school level when my oldest child entered kindergarten. That was in 1956. Over the next few years I transferred that interest to an interest in computer-assisted instruction (CAI) as computers became available in the 1960's and as time sharing on computers developed at Stanford University. At a more conceptual level, I think my interest in CAI, indeed my interest in education, is motivated by a philosophical horror of empty abstractions, that is to say, second-story talk as opposed to ground-story talk. Also, my philosophical tastes have pushed me into operational and empirical research that has been both rewarding and satisfying.

This evening, however, I want to tell you about our overall work in CAI and some of the work we are planning for the future in our network of deaf schools. I do not pretend to be an expert on education for the deaf, but I am learning and I expect to learn more from many of you here.

Our work at Stanford began in 1963 when we received a grant to set up a laboratory--a computer-based laboratory in learning and teaching--and we have been experimenting and finding our way since then. A few years ago, through informal contact with Kendall School and especially Tom Behrens, we began work with deaf children at Kendall. Out of that contact two years ago developed the idea of extending the work in CAI to a network of deaf schools around the country. Thus, we proposed about eighteen months ago that a network be set up connecting our computer at Stanford to four or five deaf schools in different parts of the United States.

Let me give you a rough idea of that network. From the computer at the Institute for Mathematical Studies in the Social Sciences (IMSSS) at Stanford, we reach the California School for the Deaf at Berkeley, California; we reach classrooms for the deaf in nearby Palo Alto; and we reach day schools for the deaf in San Jose, which is slightly south of us. Outside of California we reach Texas School for the Deaf in Austin, Texas. In Washington, D.C., we have expanded our work at Kendall School and at the Model Secondary School for the Deaf, both of which are at Gallaudet College. All connections between IMSSS and the schools mentioned above are by telephone line. Figure 1 shows a student at a teletype terminal at the California School for the Deaf in Berkeley, California. The look of things is similar to that at other schools.

Figure 1. Student at a teletype terminal at the California School for the Deaf, Berkeley, California.

Before I turn to a detailed account of what we are doing, I shall list the courses offered in the network at this time.

1. Arithmetic Drill-and-Practice Program
2. Language Arts
3. Basic English
4. Mathematical Logic and Algebra
5. Tutorial Computer Programming Courses: BASIC and AID
6. Experimental Course in Transformational Grammars

Even though we have been working with CAI for eight years, it is fair to say that our work is just begun. As we plan for the future, we want to deepen the interaction between the children and the computer programs. We want to exploit the most salient feature of CAI--its great potentiality for individualizing curriculum instruction.

Let me briefly describe our elementary mathematics program. To initiate a program on the terminal, the student is asked to type his name and number. After he types a three-digit number and his first name, the system confirms his response by typing his last name. We have the characteristic problems occasionally of students typing something like "007" and have come up with characteristic messages like CUT OUT THAT FOOLING AROUND. Usually, a message of this type is quite enough.

This is the format of a simple problem.

8 x 9 = ______

If the student, using the upper keys on the keyboard, types in the wrong answer, the computer immediately types WRONG. One aspect of individualizing instruction, of course, is that the student gets a response from the computer within 2 seconds. Thus the student does not have to wait, even as he would in a small classroom, for the teacher to evaluate his answer.

Sometimes we are asked "What can first graders do at a teletype terminal with a keyboard?" Clearly, they do not know how to type, and I emphasize that we do not expect elementary-school children to type. However, we do expect them to use a few characters to make responses. In the case of the first-grade children in the mathematics curriculum, they mainly respond by using the top row of the keyboard where the numerals are.

STRANDS PROGRAM IN MATHEMATICS

The most extensive curriculum development at the Institute has been in the drill-and-practice program in arithmetic. The final arithmetic curriculum appropriate for Grades 1-6 and, remedially, for Grades 7-9 was constantly revised during the years from 1964 to 1968. This curriculum, although utilizing the computer to present a program individualized in terms of difficulty of problems, immediate feedback, self-pacing, and review materials, did not break away from the basic model of drill and practice provided in the traditional classroom.

During the summer of 1968, development began on a major revision of the drill-and-practice program. The revised program evolved when attention was diverted from a program which could duplicate and expedite classroom procedures for a given grade to a program which could provide the most efficient drill for a given individual from the start of Grade 1 through the end of Grade 6. The questions used to determine what types of problems a child should receive on a drill changed from "What grade is the child in?" and "What is usually taught at that grade level?" to "What concepts has this child mastered?" and "What should this child learn next?"

Attention to the child rather than to the classroom resulted in a reorganization of the drill-and-practice material in elementary-school mathematics into ungraded strands. The student, working on several strands simultaneously, begins at the bottom of a strand and moves upward on each strand as a function of his ability to perform correctly on that strand. Since movement along a strand depends on the student, the level of performance on one strand relative to the level of performance on other strands creates a problem set for one student different from the problem set for another student. Thus, unlike in the traditional classroom, each student is solving a different set of problems, and each set of problems contains problem types from each strand appropriate to the ability level of the student involved.

The strand system consists of three major elements:

1. A curriculum structure that classifies the problems appropriate for an elementary-school mathematics program;

2. A set of rules for determining the problems to be presented to each student;

3. A set of rules to define the progress of a student through the structure.

Curriculum Structure

The present curriculum structure contains 15 strands. Each strand includes all problem types of a given concept (e.g., fractions, equations) or of a major subtype of a concept (e.g., horizontal addition, vertical multiplication) presented in Grades 1-6. Table 1 shows the 15 strands and the portion of the six-year curriculum for which they are appropriate.

Within each strand, problems of a homogeneous type (e.g., all horizontal addition problems with a sum between zero and five) are grouped into equivalence classes. Each strand contains either 5 or 10 classes per half year with each class labeled in terms of a grade-placement equivalent. A problem count of problem types occurring in three major elementary-school mathematics texts (Clark, Beat[illegible], Payne, & Spooner, 1966; Eicholz & O'Daffer, 1966; Suppes, 1966) and data collected during the past three years of the drill-and-practice program at Stanford were used to arrange the equivalence classes in an increasing order of difficulty and to insure that new skills (e.g., regrouping in addition) were introduced at the appropriate point in the curriculum. An example of the equivalence classes for the horizontal subtraction strand is shown in Table 2.

In addition to the ordering of the problems within a strand, we must know how much emphasis is needed on each strand at a given point in the year. To determine this, we divided the curriculum

TABLE 1

Content and Duration of Each Strand

Strand	Content	Grade Range
1	Number concepts	1.0-7.0
2	Vertical addition	1.0-6.0
3	Horizontal addition	1.0-3.5
4	Vertical subtraction	1.5-6.0
5	Horizontal subtraction	1.0-3.5
6	Equations	1.5-7.0
7	Horizontal multiplication	2.5-5.5
8	Vertical multiplication	3.5-7.0
9	Fractions	3.5-7.0
10	Division	3.5-7.0
11	Measurement	1.5-7.0
12	Decimals	3.0-7.0
13	Laws of arithmetic	3.0-7.0
14	Negative numbers	6.0-7.0
15	Problem solving	3.0-7.0

TABLE 2

Revised Horizontal Subtraction Strand

Problem	$a - b = x$	$a - b = x$	$a - b = x$	$a - b = x$	$a - x = c$
Limits	$0 \leq a \leq 4$	$5 \leq a \leq 9$ $b = 0$ or 1 or a	$5 \leq a \leq 7$ $b \neq 0$ or 1 or a	$8 \leq a \leq 9$ $b \neq 0$ or 1 or a	$0 \leq a \leq 4$
Equivalence class	1.0	1.1	1.2	1.3	1.4
Problem	$x - b = c$	$a - x = c$	$x - b = c$	$1a - b = xy$	$1a - b = x$
Limits	$0 \leq x \leq 4$	$5 \leq a \leq 9$	$5 \leq a \leq 9$	$a \geq b$ a and b can $= 0$	$0 \leq a \leq 4$ $a < b$
Equivalence class	1.5	1.6	1.7	1.8	1.9
Problem	$1a - b = x$ $1a - b = xy$	$1a - x = c$	$1x - b = c$	$a0 - b0 = x0$ $100 - b0 = x0$	$ab - c = xy$
Limits	$5 \leq a \leq 8$	$0 \leq a \leq 8$ $a < x$	$0 \leq x \leq 8$ $x < b$		$b \geq c$
Equivalence class	2.0	2.1	2.2	2.3	2.4
Problem	$ab - cd = xy$	$1a0 - b0 = 1x0$	$1ab - cd = 1xy$	$2b - c = 1x$	$ab - c = xy$
Limits	$b \geq d$		$b \geq d$, $a \geq c$	$b < c$	$b < c$, $a > 2$
Equivalence class	2.5	2.6	2.7	2.8	2.9
Problem	$ab - cd = x$	$ab - cd = xy$	$a - x = c + d$	$ab - xy = cd$	$xy - ab = cd$
Limits	$b < d$ $a = c + 1$	$b < d$ $a > c + 1$		$b > y$	$y > b$
Equivalence class	3.0	3.1	3.2	3.3	3.4

NOTE--a, b, c, d = digits in problem as presented to student; x, y = digits in response; italicized characters do not appear in problem as presented to student.

into 12 parts, each corresponding to half a year. A probability distribution function was developed for the proportion of problems on each strand for each half year. Both the problem count from the three textbooks and the average latency for problem types based on past data were used to develop the curriculum distribution. The final proportions in terms of time and problems for each half year for each strand are shown in Table 3, with the exception of Strand 15 (problem solving) which is handled separately.

Rules for Sampling Problems

Since the curriculum distribution is a function of the curriculum and in no way accounts for individual differences in performance, a sampling function was defined to determine which problems a given student would receive. The sampling function, calculated weekly for each student, is a weighted combination of the curriculum distribution and a subjective distribution. A student's grade placement on each strand is defined as the grade-placement equivalent associated with the equivalence class of problems he is being presented. For each student the curriculum distribution is selected to correspond to the half year that includes the student's average grade-placement performance on the strand curriculum. For instance, if the student's average grade placement is 3.3, then the curriculum distribution for the half year (3.0-3.5) will be used to calculate the sampling function, even if the student is enrolled in a fourth-grade class. The subjective function is a normalization of the

TABLE 3

Proporation of Time and Proportion of Problems for Each Strand in Each Half Year

Strand	Initial point of half-year interval																							
	1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0		5.5		6.0		6.5	
	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP	PT	PP
1	50	36	24	18	24	16	17	12	10	10	5	4	7	8	7	8	8	10	11	14	14	20	10	10
2	10	14	10	12	9	12	19	22	19	20	7	6	8	10	2	2	3	4	1	2				
3	26	32	21	28	21	26	9	10	8	8														
4			9	12	8	12	15	18	22	20	10	8	13	10	3	2	3	4	1	2				
5	14	18	10	14	16	16	9	10	4	4														
6			17	10	12	10	16	12	17	16	14	12	17	20	7	8	5	8	7	12	7	12	8	10
7							7	10	3	6	8	14	5	10	3	6	2	8						
8											10	14	5	6	14	16	6	8	8	4	7	4	5	2
9											6	4	4	4	15	24	13	22	20	32	17	32	18	26
10											15	18	22	10	34	16	48	16	33	6	40	8	13	2
11			9	6	10	8	8	6	8	6	11	6	7	8	7	8	5	8	5	8	5	8	5	6
12									6	6	9	8	7	8	5	6	4	6	11	14	7	10	36	38
13									3	4	5	6	5	6	3	4	3	6	3	6	1	2	1	2
14																					2	4	4	4

NOTE--PT = Proportion of time; PP = proportion of problems.

distribution determined at a given point in time by subtracting the student's grade placement on each strand from his maximum grade placement at that time.

Thus, if sampling were from just the curriculum distribution, the proportion of problems from each strand for a given student would match the proportion of problems from each strand presented in an "average" textbook. If sampling were from just the subjective distribution, the proportion of problems for a given student would be largest from the strand for which his performance was lowest; the proportion from each strand would decrease as his performance on that strand came closer to the performance level of his best strand. To decide what proportion of the problems presented should be determined by the curriculum function and what proportion should be determined by the subjective function, we defined a weighting factor based on the amount of discrepancy between the student's maximum and minimum grade placement across strands. Applying the weighting factor to the curriculum distribution and the subjective distribution resulted in the final sampling function. Therefore, as the discrepancy between the maximum and minimum grade placement increases, the emphasis on the subjective distribution increases; if the student is performing at the same level on all strands, emphasis is on the curriculum function alone.

Progress Through the Strand Structure

A student's progress through the strand structure is a function of his performance on each strand. As certain criteria of performance are satisfied for a given strand, the equivalence class from which the student is receiving problems changes, with a corresponding change in the student's grade placement on the strand. The criterion for a given equivalence class is a function of the strand and half year of which that class is a member.

For each equivalence class the criterion is stated in terms of three integers, W, Y, and Z. After every Y problems on a strand the student's performance is examined; if he did W or fewer problems correctly, he moves down one equivalence class; if he did more than W and fewer than Z problems correctly, he stays at the same equivalence class; if he did more than Z problems correctly, he moves up one equivalence class. An exception to the criterion for movement is made when a student is presented problems from a given equivalence class for the first time. In such a case, a check is made after the first three problems; if the student did all three incorrectly, he moves down one equivalence class.

The calculation of the values of W, Y, and Z for each equivalence class involved the combination of known facts, estimated facts, and several assumptions. First, knowing the amount of time a student would spend doing problems during a half year, estimating the average latency from presentation of a problem to a response from the student for each problem type (equivalence class), and assuming (for the purpose of calculations only) that the effect of the subjective distribution was negligible, we estimated the number of problems a student would receive from each strand during a half year. Then, assuming that a student has an average probability correct of .70, the values of W, Y, and Z were computed so that a student would increase his grade placement by .5 on all strands during a half year of time at the computer terminal.

LOGIC AND ALGEBRA PROGRAM

A second important curriculum in the Institute has been in the area of mathematical logic and algebra which was first demonstrated in December 1963. For this curriculum the computer program accepts any logically valid response of the student. The student is not restricted to a few multiple-choice answers, or more generally, there is not a unique constructed answer that must be given. The student inputs on the keyboard the rule of inference he wishes to apply to given premises, or to previous lines in a proof. He is not asked to type out the line of the proof itself; this is done by the computer upon command. Here are some examples of the program. In these examples, Rule AA--affirm the antecedent--is the classical rule of modus ponendo ponens.

The first two examples emphasize working with English rather than with mathematical sentences.

Example 1. Derive: We need good shoes.

Premise 1. If we buy sleeping bags, then we are warm at night.

Premise 2. If we are warm at night, then we feel good in the morning.

Premise 3. If we feel good in the morning, then we take a long walk.

Premise 4. If we take a long walk, then we need good shoes.

Premise 5. We buy sleeping bags.

In Example 1, the student would input "AA 1.5" to obtain as line (6):

6. We are warm at night.

He would next input "AA 2.6" to obtain:

7. We feel good in the morning.

After this would follow "AA 3.7" to obtain:

8. We take a long walk.

and finally "AA 4.8" to obtain the derived conclusion:

9. We need good shoes.

Example 2. Derive: Jack and Bill are not the same height.

Premise 1. If Jack is taller than Bob, then Sally is shorter than Mavis.

Premise 2. Sally is not shorter than Mavis.

Premise 3. If Jack and Bill are the same height, then Jack is taller than Bob.

In this example, the student must use modus tollendo tollens, which we call Rule DC. 'DC' stands for the fact that we deny the consequent of the conditional premise. Thus in Example 2, the student who is responding correctly would input first "DC 1.2" to obtain:

4. Jack is not taller than Bob.

and then "DC 3.4" to obtain the derived conclusion:

5. Jack and Bill are not the same height.

Example 3. Derive: $y + 8 < 12$

Premise 1. $x + 8 = 12$ or $x \neq 4$

Premise 2. $x = 4$ and $y < x$

Premise 3. If $x + 8 = 12$ and $y < x$ then $y + 8 < 12$.

In this example, the student must use modus tollendo ponens, which we call Rule DD--deny a disjunct, as well as two rules dealing with conjunctions--the rule of conjunction (FC) for putting two sentences together to form a conjunction, and the rule of simplification for deriving one member of a conjunction, Rule LC to derive the left conjunct and Rule RC to derive the right conjunct. We show the steps of the derivation in one block, but it is to be emphasized that the student inputs only the rule abbreviations and the numbers at the left of each line.

LC 2	4.	$x = 4$
DC 1.4	5.	$x + 8 = 12$
RC 2	6.	$y < x$
A 5.6	7.	$x + 8 = 12$ and $y < x$
AA 3.7	8.	$y + 8 < 12$

In these simple examples the possibilities for different proofs by different students are restricted, but already in this last example, the order of the lines can be changed, and the possibilities of variation increase rapidly as the complexity of the problems increases.

It should be mentioned that when the student makes an error, which means he attempts to take a logically invalid step, the computer program prints out the reason the step is in error and waits for him to make another move. For example, if the student attempts to apply Rule AA to a sentence in which the major connective is "and" rather than "if...then" the computer program simply prints out the message "line n is not a conditional sentence." The ability to analyze mistakes unerringly is an unusual feature of the logic program and rests upon the well-understood character of logical inference. In more diverse and open-ended subjects, the same unerring analysis of student errors is considerably more difficult.

EXAMPLE OF EVALUATION

As one example of the positive effects of the drill-and-practice program in mathematics, we present the evaluation of student performance in McComb, Mississippi, during the 1967-68 school year. Although we found significant differences in performance when control groups were compared with experimental groups in both California (1966-67 and 1967-68) and Mississippi, the average performance level of students in some of the classrooms in Mississippi was as much as two years below their grade level. These students, therefore, provided an excellent example of the benefits of CAI in a situation in which the educational environment was not sufficient to produce "average" performance.

To evaluate the CAI program we administered the arithmetic portion of the Stanford Achievement Test (SAT) in October for Grades 2-6 as a pretest, in February for Grade 1 as a pretest, and in May for Grades 1-6 as a posttest. Tests were given in 12 different schools in Mississippi; 8 of these schools included both experimental and control students, 3 included only experimental students, and 1 included only control students. Within the experimental group, 1-10 classes were tested at each grade level; within the control group, 2-6 classes were tested at each grade level. (For a description of the SAT and a listing of the levels administered as a function of grade, see Suppes & Morningstar, 1969.)

The response measure used to determine the change in performance level for the year was the difference between the posttest and pretest grade placement on the SAT computation section for each grade. The results of the t test applied to the difference between experimental and control groups on this measure and the average pretest and posttest grade placements for each grade are shown in Table 4. The performance of the experimental students improved significantly more than that of the control students in all six grades. The difference between the experimental group and the control group was the largest in Grade 1, where in only three months the average increase in grade placement for experimental students was 1.14 compared with .26 for control students.

In addition to the results from the computation section of the SAT, the performance of students in the experimental group was significantly better than that of the students in the control group on the concepts section of the SAT for Grade 3, $t = 3.01$, $df = 76$, $p < .01$, and Grade 6, $t = 3.74$, $df = 433$, $p < .01$, and on the application section for Grade 6, $t = 4.09$, $df = 433$, $p < .01$. In Grade 4, the control group improved more than the experimental group on the concepts section, $t = -2.25$, $df = 131$, $p < .05$.

SOME THOUGHTS ON THE FUTURE

Without giving the subject much reflection, one might think the appropriate model for a dialogue should be Socrates at work in the Platonic dialogues, but it does not take much perusal of Plato's writings to recognize that this is not a serious pedagogical or psychological model of how an instructive or tutorial conversation should take place. The real problem is that we do not have a good intellectual model that is well enough developed for the interaction between a tutor and his pupil.

TABLE 4

Grade-Placement Scores on the SAT: Mississippi 1967-68

Grade	Pretest				Posttest		Posttest-pretest		t	df
	Experi-mental	N	Control	N	Experi-mental	Control	Experi-mental	Control		
1	1.41	52	1.19	63	2.55	1.45	1.13	.26	9.63*	113
2	1.99	25	1.96	54	3.37	2.80	1.38	.84	4.85*	77
3	2.82	22	2.76	56	4.85	4.04	2.03	1.26	4.87*	76
4	2.34	56	2.45	77	3.36	3.14	1.02	.69	2.28*	131
5	3.09	83	3.71	134	4.46	4.60	1.37	.89	3.65*	215
6	4.82	275	4.35	160	6.54	5.49	1.72	1.13	4.89*	433

NOTE--This table originally appeared in Suppes & Morningstar (1969). Some minor computational errors that do not affect the interpretation of the results have been coorected.

$*p < .01$.

We therefore do not have a sharply defined analytical model that we can plan to simulate in formulating powerful computer programs. The central difficulty in the area of interaction between student and program is not the clumsiness or limitations of the computer, but our ignorance in understanding in any explicit way the character of a successful dialogue. A large number of topics being studied either as a part of computer-assisted instruction or as part of artificial intelligence should contribute to a deeper understanding of the nature of dialogue. I shall mention only a few special topics, since I see no point in trying to deal with this difficult problem in a general way.

Let me mention some of the things we are planning under this general heading for the logic and mathematics programs I have described as part of our activity at Stanford during the past decade. Perhaps the central limitation of these programs at the present time is their requirement that the student construct an explicit formal proof for every theorem. Somehow the routine steps of more advanced mathematical work must be compressed and eliminated from the student's explicit focus of concern in order to provide adequate time to concentrate on the crucial conceptual steps in a given proof. Published mathematical proofs, even in relatively elementary textbooks, are far from formally complete. We must close the gap between this formal incompleteness and the theoretical conception of a proof in the formal sense. The most promising approach to this central problem in the development of more advance mathematics courses in CAI is the use of theorem provers for instructional purposes. With theorem provers the student can instruct the program to move from one point to another in the proof. The steps in these moves are modest and of the right level of difficulty for theorem provers; they cover the many routine steps that are tedious and far too boring for the student to make explicitly if he is called upon to prove any genuinely interesting theorems. For example, repeated use of the commutative and associative laws in a fashion that is common in elementary algebraic arguments would be turned over to the theorem prover to execute. The same remark applies to all standard arguments using sentential or predicate logic. Once the student has learned the elements of sentential and predicate logic, the routine applications may properly be assigned to the theorem prover by the student.

As one mode of operation for the use of theorem provers, we introduce an additional instruction into the proof procedures, an instruction called show. In this case the student inputs what he wants the theorem prover to show; he also indicates the preceding theorems and axioms from which the intermediate result should be derived. Our theorem prover is of sufficient power to take these intermediate steps, but not adequate to take the larger steps required for an entire proof. There is good reason to believe that this will probably be the situation for several years. My own feeling is that the instructional use of theorem provers is perhaps one of the best operational arenas in which to develop and improve on the results accomplished thus far. Without a facility such as a theorem prover I see little hope of being able to give self-contained courses that catch the spirit of more advanced parts of mathematics in the sense of requiring the student to give proofs of the main theorems.

A second and closely related activity for which theorem provers are a necessary ingredient is that of monitoring a student's activity while he is in the process of searching for a proof and then giving him hints of how he may complete the proof he has begun. Again, at least in elementary and semi-elementary domains of mathematics, there is hope of concretely realizing programs of this sort. The data base is simple, namely, the elementary mathematical theory, together with the data on the student's current attempt at a proof. Investigations of ways in which to complete the proof begun by the student are in such contexts not overly difficult. The theorem prover searches for a way to complete the proof and then gives the student a hint of the next step to take when he has run out of conjectures himself. Preliminary work that we have begun on this line of attack seems promising. I do not for a moment underestimate the problems of extending our work to more complex bodies of mathematics. I do think it is an important direction for developing richer mathematical courses in a computer-based environment.

In many respects we can expect to make the most rapid progress in the domain of mathematics, because of its limited data base, the formality and explicitness of its language, and our own very explicit understanding of the structure. The development of tools to provide aids and hints in other domains will not be a simple matter. There is currently a variety of attacks on the development of good question-answering systems. Although adequate systems are still far from available, it seems likely that the development of question-answering systems for use in instructional settings will be an important part of research in CAI during the seventies.

I would like briefly to mention some of my own work in this area, expecially work conducted in conjunction with Dr. Hélène Bestougeff of the University of Paris. Dr. Bestougeff and I are attempting to write a question-answering system with certain features that have previously been missing in the literature and that we think are probably highly desirable for future progress in this domain. The central objectives of our study can be described very simply. We are attempting to define for the question inputs and answers a machine-independent grammar and sematics such that when the program is constructed we can prove a theorem asserting that every question is answered correctly. Of course, by saying that every question is answered correctly we mean that every question is answered correctly relative to the data base. Without an explicit grammar for the fragment of a natural language used for the input questions and without an explicit semantics for this fragment, it is impossible to prove a formal theorem about the nature of the question-answering system. As in other domains of science, there is also a hope that by introducing a deeper structure into the question-answering system--such as the kind introduced by an explicit grammar and semantics--we shall be able to handle more efficiently and develop more easily the actual system itself. Whether or not my conjectures about this direction of development are correct, there seems to be little doubt that progress in this area will be a significant part of CAI work in the coming decade.

The possibilities of developing methods for a rich dialogue between student and computer program seem especially important for the education of deaf students. It is natural to remark that in the case of students with normal hearing the proper mode of interaction is voice-to-voice communication, and no doubt, what can be described in principle will be realized in practice in the near future. The important point to emphasize here is that communication between student and computer in the case of deaf students can be achieved using the teletype or a similar terminal device as the normal and most effective mode of communication. Teletypes fortunately can be installed at a fairly reasonable price, and indeed, as most of you know, have already been used extensively for communication between deaf persons over telephone lines.

The problem for us in the Institute and in other research groups is to come to an understanding of how we can create an appropriate dialogue at a teletype between the deaf student and the computer program. There are no serious technological limitations on what we can do. All difficulties are entirely intellectual and scientific in character. As yet, however, we simply have a very shallow and insufficient understanding of how a dialogue is to be characterized, how a computer program is to be written to respond in dialogue form to a student, how the computer program is to understand the meaning and the intent of the communication from the student.

I do not wish to end on the note that this is an impossible problem for our present scientific tools of analysis. I think, in fact, that we are just on the verge of having available the appropriate grammatical and semantical methods, and there is a real hope for much greater progress on these matters in the immediate future. I can think of no aspect of educational research that could turn out to be more fruitful for deaf students.

The research reported in this paper has been supported by National Science Foundation Grant NSFG-18709 and Office of Education Grant OEG-0-70-4797(607).

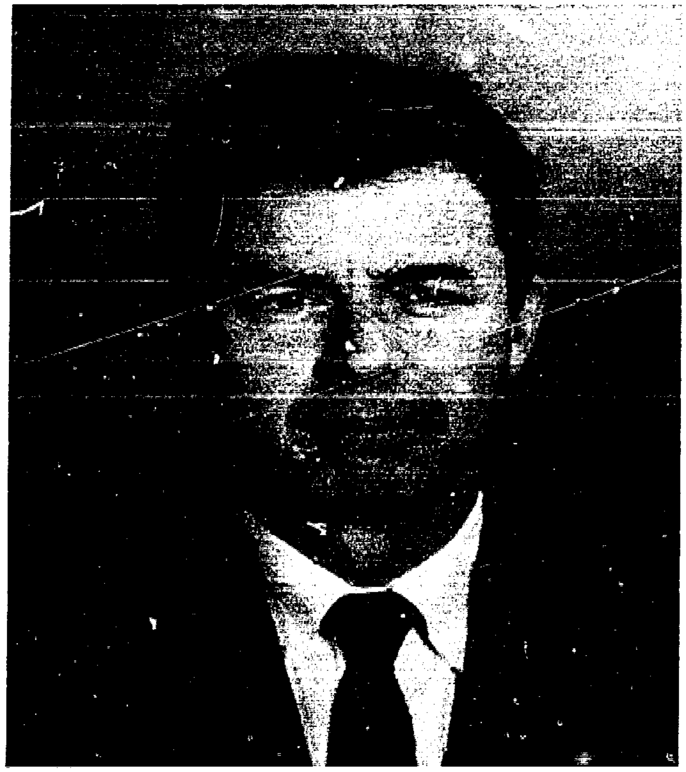
References

Clark, C.H., Beatty, L.S., Payne, J.N., & Spooner. G.A. Elementary Mathematics, Grades 1-6. New York: Harcourt, Brace & World, 1966.

Eicholz, R.E., & O'Daffer, P.G. Elementary School Mathematics, Grades 1-6. Palo Alto, California: Addison-Wesley, 1968.

Suppes, P. Sets and Numbers, Grades 1-6. New York: Singer, 1966.

Suppes, P., & Morningstar, M. Computer-Assisted Instruction. Science, 1969, 166, 343-350.



Dr. Donald Torr is the Director of the Office of Educational Technology and a Professor of Education in the Graduate School of Gallaudet College. He joined the faculty at Gallaudet in September, 1969. For two years prior to that time he was Managing Director of the Educational Technology Center of Sterling Institute. The Center was responsible for the development of a one semester economics course for the U. S. Naval Academy, including the preparation of performance objectives and the writing and validation of the instructional materials for individualized instruction. The project was funded by the U. S. Office of Education over a three year period.

For eight years Dr. Torr was with the General Electric Company. For the bulk of that time he was the Manager of Human Factors and Training in an Information Systems Operation. During his last year he worked within the subsidiary, the General Learning Corporation. In this latter position he was responsible for a contract with the Office of Naval Research which required the development of a five year plan for the implementation of a Computer-Aided Instruction Research and Development Center.

Dr. Torr also worked nine years within the government, seven years with the Personnel Research Laboratory of the Air Force and two years with the National Security Agency. This work was largely psychometric in nature. He received his Ph.D. in 1952 with a major in education from Washington University in St. Louis.

INTRODUCTION

This paper describes a graduate course which properly can be classified "Programmed Learning for the Deaf Student" as about one-fourth of the 50 students who completed the course at Gallaudet College in the summer and fall sessions of 1970 were deaf. The Educational Technology course qualifies for that classification in a second sense because the terminal performance objective (behavioral objective, instructional objective, etc.) required each student to produce a self-instructional package of learning material. The package was to be prepared with the intent of producing behavior of a specified type by a deaf student. The paper describes the organization of the course, discusses some of the instructional material prepared by the students and provides some evaluative comments.

ORGANIZATION OF THE COURSE

The course is designed to foster individualized study. The content is organized as shown in Figure 1. Units of instruction are brought together into what I call Instructional Packages (I.P.).

On the first day of the course we meet as a group and after a brief interchange, including introduction and a very short overview, the students are asked to read the first Instructional Package. That package introduces them to the subject matter, defines major terms, outlines the organization of the course and how they are to operate within it, and states very specifically the terminal performance objective of the course, i.e. the delivery of a self-instructional package. Thus, they know on the first day they enroll in the course just what is expected of them. From that point on the student is free to choose his path with the exception that certain Instructional Packages must be taken in a prescribed sequence.

To prepare for this course it was necessary to produce the Instructional Packages and to design a facility laycut conducive to this type of learning environment. I will first describe some of the I.P.'s.

As suggested in Figure 1 some of the instruction deals with materials and equipment. The emphasis is on the development of motor skills. Other instruction deals with concepts and, therefore, emphasizes the development of mental skills. In both instances it is important that the student know what is expected of him. Further, he is to be made aware

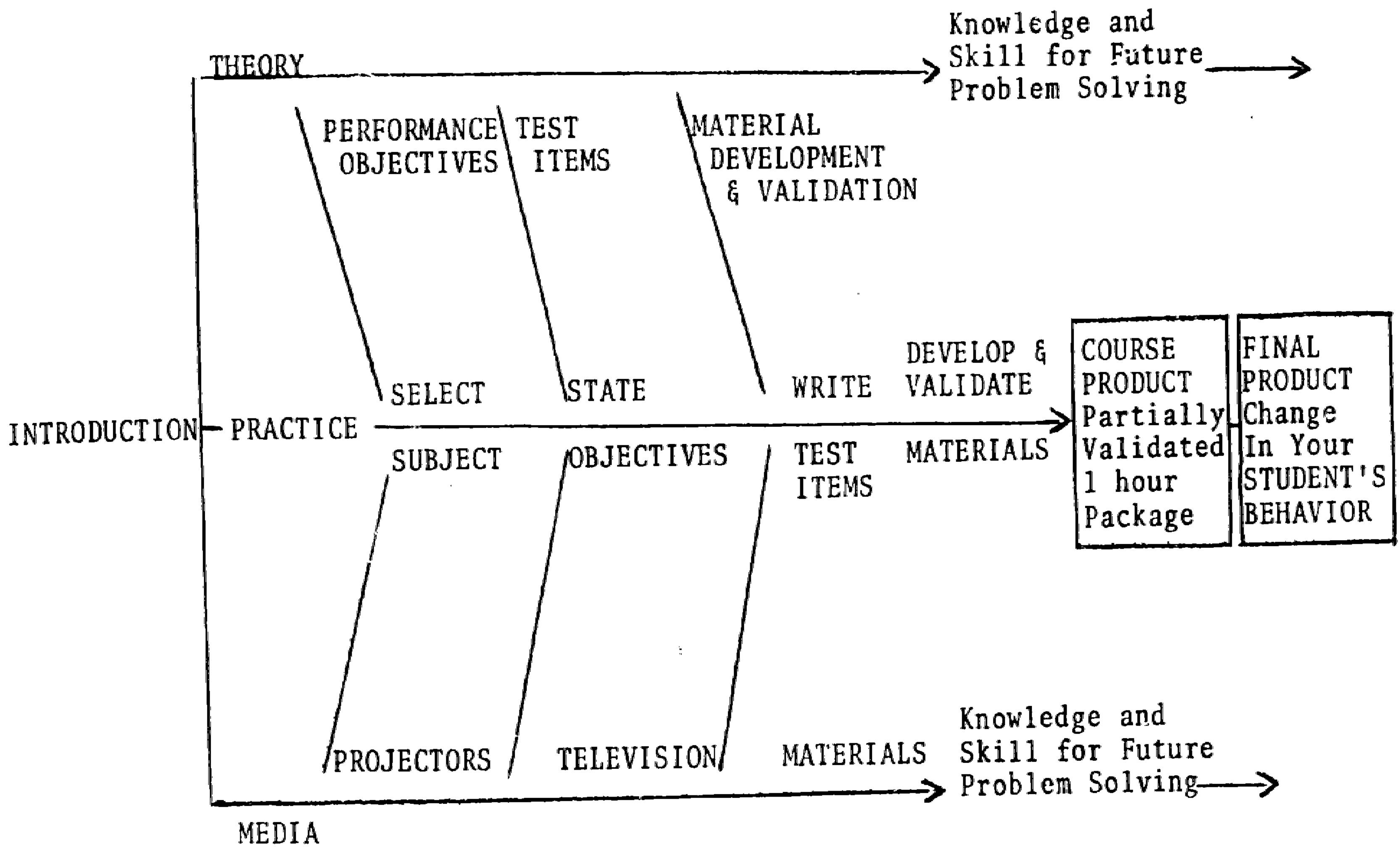


Figure 1. General Structure of the Course

of whether he is succeeding, i.e., he is to receive feedback on the appropriateness of his responses. In the operation of equipment, feedback comes from the equipment itself. The machine tells the student if he is right or wrong. Some equipment manuals seemed quite clear to me so the Instructional Package was merely designed to bring the student, the manual, the equipment, and necessary materials together in a manner which permitted learning to take place. In other instances, some additional instructional support seemed to be needed. In the case of operation of a filmstrip projector, an 8mm projector, and the assembly and operation of television recording equipment, colored slides were made to demonstrate the sequence of steps to be followed. The slide series was first put together in a storyboard format, i.e., each slide to be made was first sketched and placed in an order judged by me to be appropriate. The sketches were then used with a naive subject to ascertain if he could operate the equipment by following the sketches. Changes were made when problems were encountered. When the sketches required no further improvement the scene was set and the photographs were taken.

In presenting concepts to the students I resorted to textual material and utilized a programmed format. In each Instructional Package the student is given the performance objective for the package. A variety of information feedback techniques is used to give the student some experience with them. One of the techniques used is the QRS response board. As the student reads the text he tests himself by responding to multiple-choice questions. To do so he depresses one of five keys on the board, thus identifying his response. By depressing the key he also punches a hole in a porta-punch card. If he is correct the hole permits the closure of an electrical circuit and a green light glows. If he is not correct he may be branched to study further and then required to make another selection. The punched card provides a record of responses for my use as I evaluate the adequacy of the I.P.

This same QRS device is also used for pretesting and post-testing the students as required by the performance objective. When used in this way the student is given no feedback, since the purpose of the testing is to assess the student's knowledge at that point in time to help determine the type of instruction that should follow. Cards carrying the students' responses to these questions are scored to determine if the student meets the criterion set by the instructor. The cards are stored for future analysis to determine the need for revision of the instructional material.

To provide for the type of course implied by the above description it was necessary to modify the teaching facility. One 17' by 21' room is equipped with 12 carrels. The carrels are made from 2' by 4' tables to the top of which visual baffles are added. The baffles are 2 feet high and are placed at the two ends and across the back. A strip of electrical power outlets is also placed across the back. The interior surface of each end baffle is painted matte white to serve as a projection surface. In addition to the carrels there is a desk for a room Monitor and storage space for instructional materials, equipment, and supplies. The Monitor logs equipment and materials in and out and scores and logs pre- and post-test results.

This room is used for the study of self-instructional material including that associated with small equipment. The design of the carrels permits the student to learn how to operate one piece of equipment by viewing pictures displayed by a projector or to use a variety of instructional media in pursuing a unit of study, assuming that the instructor has prepared his course to include that variety.

A second room, 17' by 20' in size, is used as a group meeting room and as a camera and television studio. Shortage of classroom space has limited the use of this room. Eventually I hope to see the use of stackable chairs which are easily cleared to free the room for television and photographic use.

A third room, 9' by 17', is used for student practice with TV equipment. The room has a "permanently" installed television monitor and television recorder for viewing video tapes. A student in practice teaching might review his own performance in the classroom or share that review with an instructor. The tapes in this instance would have been made using small portable television recording equipment. The second and third rooms mentioned are separated by a wall containing a one-way mirror which of course adds to the flexibility with which they can be used.

I have been conducting a course in educational technology using the type of instructional material described in the facility described. Lecture meetings have been limited because I feel a lecture by myself to be a very inefficient means of communicating with students unless I am unprepared to communicate in a more efficient way, e.g., by providing printed text. A graduate student should read at from 300 to

600 words a minute. I lecture to hearing students at about 120 words per minute. Using the simultaneous method of communication, my transmission rate is about 70 words per minute. Thus, if there is a large volume of information to be transmitted I would hope that it could be read, because the transmission is so much more efficient on a time dimension. Also, of course, the student has the freedom to study at the pace which is proper for him.

My major contact with students has been on an individual basis. I try to start them down the central path shown on Figure 1 as quickly as possible. I ask them to identify the age level and the subject matter for a course they plan to teach to deaf children. Then, I ask them to specify in performance terms the behavior they would want to see a child exhibit after one half to one hour of study. We spend some time on this because it is the initial acquisition of the principal skill I hope they will learn from the course. We then work together discussing the strategy that will be used to produce that performance, the test which will be used to assess the student's performance, the means of providing feedback to the student as he studies by himself, and the medium or media to be used to transmit the information.

STUDENT PRODUCTS

I would like to turn now to some of the programmed instructional material developed by students in this course. Since my students were teaching or planning to teach at every level from preschool through undergraduate college I will discuss the material by level, recognizing that the level is quite arbitrary.

Preschool. This is the level that caused me the greatest concern when anticipating possible problems with this new course in educational technology. I had watched preschool teachers trying to communicate with small deaf children and realized that I was asking a lot of a teacher in training when I asked her to prepare material which would permit the child to learn alone without her constant involvement. My students were also apprehensive, but we think some interesting developments evolved. To keep this paper reasonably short I will give an abbreviated summary of the material. Liberties were taken with the objectives to reduce their size.

1. Objective: The mother will behave in everyday situations in a manner that is likely to give her child many opportunities to look at her face. (A checklist of behavior is included.)

Purpose: Home training for the hearing parent of a young deaf child.

Instruction: Paper. Describes the objective and the rationale for it. Gives parent a series of likely situations (shown in photos) and asks the parent to choose their response. Response causes branching to appropriate additional comments. Second section calls for constructed response and provides feedback.

Testing: Specified situations to be observed in the home or training center, complete with checklist for behavior observed and criterion number for success.

2. Objective: The child will unbutton and button buttons of various sizes and will assign the number 1, 2, or 3 to displays containing 1, 2, or 3 objects.

Instruction: Colored felt books which the child manipulates after demonstration by teacher. Feedback on number concept - number sticks if it is correctly selected by child, does not stick if it is wrong.

Testing: Teacher observes number placement.

3. Objective: The child will complete a pattern from left to right to reproduce a given stimulus.

Purpose: Reading readiness training.

Instruction: Using Project LIFE Program Master, or equivalent, the child is given a series of stimulus slides and an opportunity to identify the control button which will permit the stimulus pattern to be reproduced from left to right on successive slides. Selection must be correct before he can proceed (under control of machine).

Testing: Independent set of slides.

4. Objective: The child will identify the words (specified) when shown the picture of the person, or select the picture of a (specified) when shown the word.

Purpose: To add practice material to the Project LIFE material.

Instruction: Uses Project LIFE Program Master and slide projector in the same manner followed by the Project LIFE Materials.

Test: Independent set of slides.

5. Objective: A visually handicapped and hearing impaired child will select a lighted picture pattern to communicate her intention.

Purpose: To attempt to establish a mean for communication with the child described.

Instruction: Time did not permit the implementation of this objective. Functional specifications for a lighted communication board were developed and investigations of the use of light as a reinforcing medium were carried out.

Elementary School

1. Objective: The child will correctly insert a or an in a printed sentence.

Instruction: Paper program with mask for feedback. Begins with practice on vowels and their tie to an and then introduces the "other" letters (consonants) and their tie to a.

Testing: Series of sentences.

2. Objective: The child will print b or d as required by the test material.

Purpose: To provide practice for a child who is failing to discriminate between b and d.

Instruction: A series of activities requiring manipulation of b and d and providing discrimination practice via tactile and visual experiences. Feedback provided through physical cues, e.g., letter fits or doesn't fit in opening.

Testing: Paper.

3. Objective: The child will correctly label a series of leaves with the help, if necessary, of a reference book.

Instruction: All stimulus material consists of actual leaves, seeds, etc., including the reference book. Materials have been laminated, using an iron and laminating film, and then mounted.

Testing: Set of leaves and reference book.

4. Objective: Child will properly sign: mother, father, sister...when shown pictures (related objectives).

Purpose: Deaf graduate student who will start school for deaf in Africa wants to establish a minimal set of signs for communicating with children 5-14, who have no common means for communication.

Instruction: Paper program with pictures of object or person and associated sign. Teacher demonstrates entire series first and then children practice on their own with the booklet. Feedback on the obverse side of each stimulus page.

Testing: Series of pictures.

High School

1. Objective: Student will correctly insert the pronoun he, she, we or they in a sentence, given an equivalent sentence, e.g., Tom went to the store, write He went to the store.

Instruction: Paper with drawings. Linear program.

Testing: Printed list.

2. Objective: Given a paragraph from a story the student will select the one picture of three closely related pictures which best matches the narrative.

Purpose: Practice in reading for detail.

Instruction: Printed story of The Legend of Sleepy Hollow and set of slides, one slide for each paragraph in story. Each slide contains three closely related drawings. Slide projector controlled by QRS board. Student depresses key corresponding to his selection of proper picture in each slide. Feedback: green light correct, no light incorrect.

Testing: Independent set of slides and accompanying paragraphs.

3. Objective: Given 5 slides, each depicting an action about to take place, the student will write a sentence for each slide using the word about as it means "on the verge of."

Instruction: A series of slides depicting action about to take place and tied to a branching text requiring continual responses and developing the specified writing skill.

Test: Independent set of slides.

4. Objective: Given the following word pairs (specified) the student will write the equivalent contraction. Given the following contractions (specified) the student will write the equivalent word pair.

Instruction: Paper with a mask. Linearly programmed within branches.

Testing: Paper lists.

5. Objective: Given a set of sentences requiring the insertion of the word and or but the student will insert the correct word.

Instruction: Paper, linearly programmed.

Test: Paper.

Many additional programs appropriate for the high school level were written, including several in English and mathematics; one each in physics, chemistry and art and others on the use of the dictionary and the Reader's Guide.

EVALUATION AND CONCLUSIONS

I feel, on a subjective basis, that the educational technology course has been successful in introducing students to some of the advantages of individualized instruction. A major concern I have at this point has to do with the amount of time I had to spend with individual students. While I personally found this individual contact the most enjoyable part of the course I am not certain how many students I could handle on a full-time basis. I have empirical data now on some 50 students and know that I can cut down some of the time required for individual contact by improving and greatly augmenting my written material. I know, also, I must add more self testing for the students because I found myself repeatedly explaining material which had been dealt with in a written form and which I feel the students could have mastered without me.

I am encouraged by my experience with this course because

I now believe teachers can be relatively quickly oriented to the development of self-instructional material. I do not mean that they can become skilled in a single course but they can, I believe, produce a product which is worthy of validation, on almost any subject and at any level.

Long before teaching this course I had come to the conclusion that this country needs to spend hundreds of millions of dollars on the development of instructional materials for general education which would permit individualized learning. These materials are also needed in the field of special education, augmented to accommodate such problems as are intensified through the different handicaps, e.g., reading for the deaf child.

To me, programmed materials are tremendously valuable when they exist in a variety and a volume to meet the needs of the teacher who is, in turn, trying to meet the many different needs of his or her students. A single programmed package is worse than useless because it allows the beast of individuality to escape. If we are to make good use of programmed material I believe we need highly coordinated curriculum materials. For this reason I plan to modify my course to restrict the range of choice given the student. In this way, I hope to begin to build coordinated sequences of instructional packages which can be used by our graduates when they leave Gallaudet College. We will also try to incorporate materials from the regional education laboratories. This effort will be modest compared to the size of the problem, but if we are able to incorporate materials such as the math curriculum, which was initiated at the

University of Pittsburgh and is now being pursued by some of the regional education laboratories, we may begin to make some significant headway.

Dr. Leo Persselin originated the electronic assembly programmed learning project in 1966, while Director of Instructional Systems Development at the Videosonic Systems Division of Hughes Aircraft Company. He directed development of the project while in a comparable position at TRW Systems, Redondo Beach, California, and is now associated with the Dubnoff School for Educational Therapy, North Hollywood, California.

Dr. Persselin received his Ph.D. in Communication at the University of Southern California. In addition to his work in curriculum development for special education, since 1968 he has taught graduate courses in learning theory and mediated instruction in the School of Education at the University of Southern California.

His papers dealing with instructional systems, programmed learning, and automated instruction have included publication in Journal of Secondary Education, Educational Technology, Society of Motion Picture and Television Engineers, Personnel Journal, and Data Processing for Management.

Figure 1. Trainee. California School for the Deaf, Riverside.

The girl in the picture is a deaf high school student who has an attention span of 15 to 20 minutes in a conventional classroom. At the end of that time, she typically not only becomes personally distracted, but also begins distracting other students with disruptive behavior.

In a programmed learning course for electronic assembly training, this same student consistently worked full 90-minute class periods with rapt attention. She refused to be distracted even by such interruptive events as the arrival of visitors.

In terms of the quality of her electronic assembly workmanship, final examination scores, and the speed with which she completed the course of instruction, she ranked second highest in a class of seven.

She entered the course with a language grade level of 3.5 and reading comprehension of 4.0. By the time she completed the course, both her language and reading vocabulary included words like: anti-wicking tweezer, bifurcated terminal, soldering, swaging, thermal, diagonal, torque, ratchet, and syringe. Not only could she follow written instructions with words like these, but also she was able to use the words in correct context, and spell them correctly.

THE PROGRAMMED LEARNING SYSTEM

In 1966, an employment survey indicated electronic assembly to be an ideal type of job for deaf high school graduates, both boys and girls. Companies which had hired deaf assemblers consistently reported good results. The work paid well, and it could represent the first step on a career ladder: the job of electronic assembler has senior and specialist grades, and on-the-job and other company-provided training can open the door for advancement to positions such as those of quality assurance inspector and electronic technician.

In 1967, Captioned Films for the Deaf initiated development of the programmed learning system described in this report. The development had two objectives: first, to create a course of vocational training to prepare deaf high school students for entry-level electronic assembly jobs upon graduation; and second, to base the course on a model of self-instruction which could serve for the creation and improvement of other curriculum, both vocational and academic.

The system currently is being demonstrated and evaluated in the California Schools for the Deaf, Berkeley and Riverside; American School for the Deaf, West Hartford, Conn.; and the Salem Rehabilitation Facility, Salem, Oregon. At the Rehabilitation Facility, the curriculum is being demonstrated and evaluated for use with other handicapped populations in addition to the deaf.

Instruction is organized into seven discrete units, each encompassing progressively more complex aspects of the electronic assembler's job. The titles of these units are: 1) Mechanical Assembly; 2) Wire Preparation; 3) Assembly Soldering; 4) Wire Installation; 5) Wire Harness Building and Installation; 6) Component Installation; and 7) Electronic Assembly Rework Techniques. In the process of completing these units, the trainee acquires the knowledge and performance skills required for assembling electronic chassis and printed circuit boards, and learns to work independently from industrial assembly drawings and wiring diagrams.

Each trainee receives individual instruction at a workbench equipped with electronic assembly tools, parts, and materials, and a 35mm slide or filmstrip projector and screen for individual viewing. Step-by-step instruction is presented in the form of coordinated programmed textbook and filmstrip materials. The trainee learns at his own pace, responding to instruction by entering written answers into his textbook, and by performing electronic assembly tasks at the workbench. Learning exercises approximate on-the-job activities as closely as possible.

Figure 2 shows a workbench arrangement at the Riverside school. The numbered and lettered bins contain electronic assembly hardware. The numbers and letters correspond to data in the programmed textbook and film materials.

The system does not eliminate the need for a classroom teacher. The programmed textbook periodically instructs the trainee to ask the teacher to check his work. In addition, the trainee may call on the teacher whenever he feels he needs help.

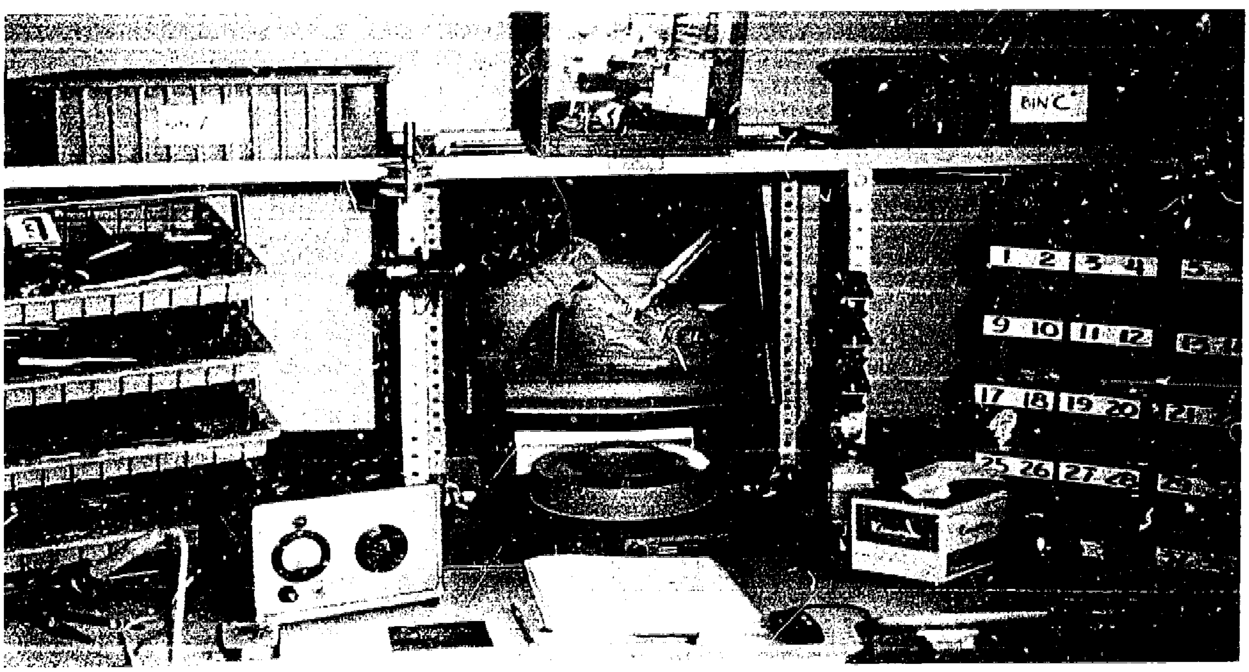


Figure 2. Electronic Assembly Workbench. California School for the Deaf, Riverside.

The teacher checks and evaluates the trainee's work with the aid of a programmed manual. If remedial instruction is required, the teacher may refer the trainee to appropriate programmed learning material or may provide supplemental instruction in person. The teacher also administers the final examination which follows each of the seven instructional units. The examination is designed to assure that the trainee has achieved all learning objectives, and to reveal any learning deficiencies which must be corrected before the trainee can go on to the next unit.

INSTRUCTIONAL CONCEPT

The concept for this instructional system is depicted in Figures 3 and 4. The diagram in Figure 3 shows a basic model of tutorial instruction: the learner receives an increment of instruction; he responds to the instruction; the response is evaluated; the learner receives immediate feedback as to the quality of the response; and selection and presentation of the next increment of instruction is made on the basis of the preceding evaluation.

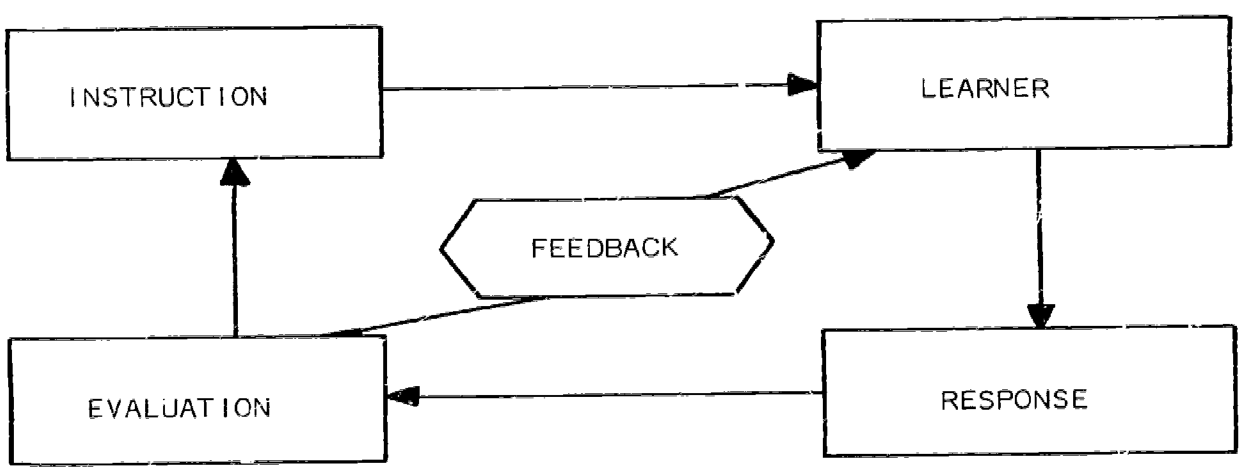


Figure 3. Conceptual Model: Tutorial Instruction.

To the extent that lesson presentation, evaluation, and feedback functions can be automated, it is possible to achieve automated, programmed instruction. Completely self-instructional programmed learning is achieved when these functions are automated to the extent that a learner may independently meet all learning objectives without requiring the presence of an instructor. "Automation" may range in complexity from simple text programs to highly complicated computer-based audiovisual programs.

Figure 4 shows the adaptation of the tutorial model which was used for development of the electronic assembly curriculum. In this model, the classroom instructor is not eliminated from the system, but rather is programmed into it. As depicted and described in the foregoing pages, instruction revolves around a program of self-instruction through which the trainee proceeds individually and at his own pace. The trainee responds to instruction through programmed learning exercises. Self-tests permit the trainee to evaluate his own work, acquire immediate feedback, and select subsequent increments of instruction.

The teacher monitors the trainee's work and the trainee's evaluation of that work, reinforces learning by confirmation of achievement, and provides supplementary and remedial instruction as required. The teacher's role essentially is that of quality assurance. It is patterned after the job of the quality assurance inspector in an industrial setting. The teacher's primary function is to assure that the standard of performance set by the program is achieved and maintained, and to be sure that the learner is aware of and corrects any deficiencies in his work.

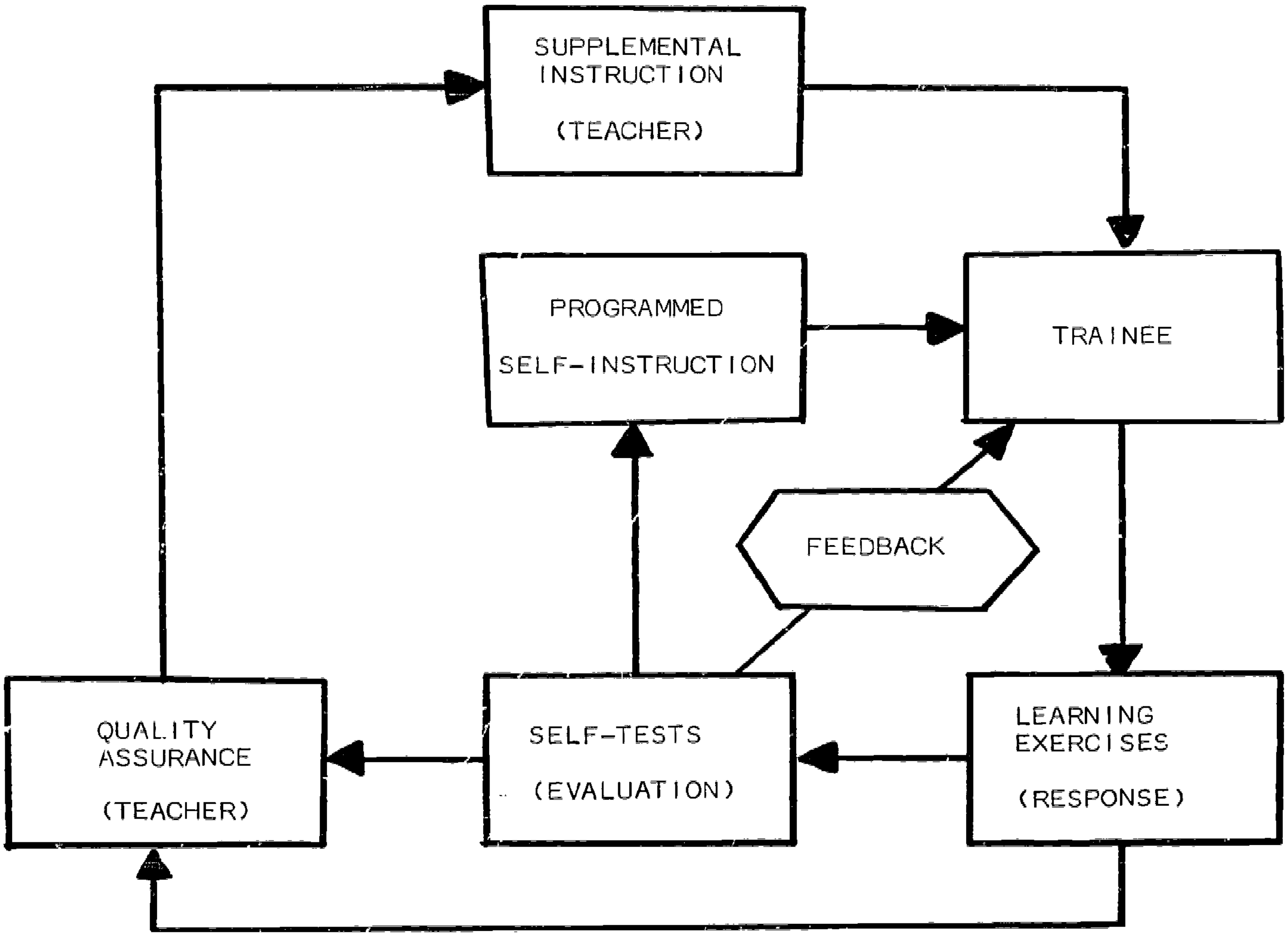


Figure 4. Conceptual Model: Electronic Assembly Programmed Learning System for the Deaf.

ANTECEDENTS

Development of this system derives from a World War II audiovisual training program for industry, industrial production-aid applications of audiovisual instruction beginning in the mid-1950's, and research in programmed learning for the deaf and for the mentally retarded.

The conceptual prototype of the system was the War Training Program of the Division of Visual Aids for War Training, U.S. Office of Education. To help cope with the training needs of wartime industry, between January 1941 and June 1945 this Program produced 457 film-based instructional units for skill training in 15 different vocational areas. The basic item in each unit was a 16mm sound motion picture: 432 of the films were each accompanied by a silent filmstrip and an instructor's manual in a program package designed as a totally integrated instructional system.[1]

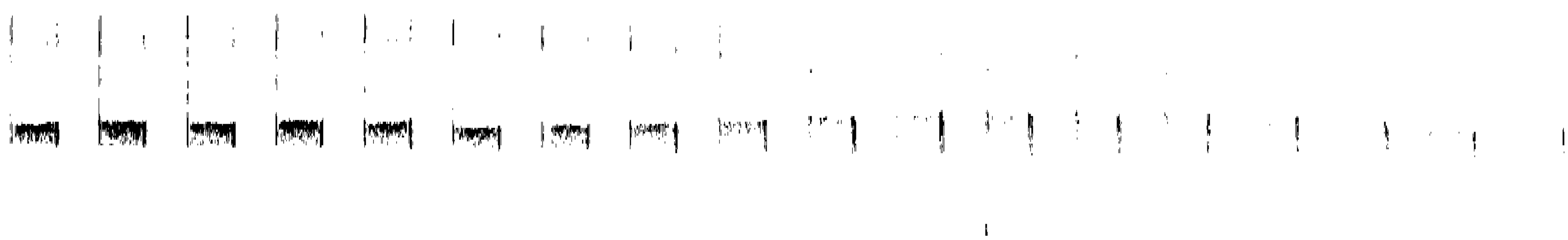
Although intended for group instruction, film materials were designed to induce the highest possible degree of individual motivation and personal involvement. First-person camera angles and stream-of-consciousness commentary were among the learner-centered techniques used to heighten the individual trainee's identification with instructional content. The filmstrip accompanying each motion picture not only provided step-by-step review of motion picture content, but also incorporated question-and-answer frames and other learner-particiaption devices. For example, the outlines of an automobile engine might be depicted in white lines on a black background. This frame could be projected on a blackboard, where the outline would show up very satisfactorily, and a trainee could be asked to chalk in the wiring system of the engine.

The approach to instruction was strictly behavioral. Use of the film packages was not intended simply to teach about the jobs involved, but to result in the actual acquisition of specific job skills. To this end, each unit in a series dealing with a particular job was limited to the instruction of a single job operation.

A dozen years after the War Training Program ended, individualized audiovisual instruction was introduced on manufacturing assembly lines as an industrial approach to improving production efficiency. In this application, as depicted in Figure 5, coordinated slide/tape presentations provided workers with step-by-step instructions leading to the completion of required assembly work. Each assembly workbench was equipped with its own slide projector and audiotape player, with the worker controlling the page of synchronized visual and audio presentations.[2]

In the late 1950's and early 1960's, this industrial application became widely used throughout the electronics industry. Results were uniformly successful. Previously required training time was cut, production output rose, and the number of rejects due to faulty work plummeted. At Republic Aviation Corporation, Farmingdale, Long Island, N.Y., for example, audiovisual instruction on the assembly line boosted productivity, cut training time, and slashed assembly costs by more than 40 per cent. In the company's manufacturing engineering section, missile-

Figure 5. Industrial Assemblers Working from Audiovisual Instructions. Hughes Aircraft Company, Fullerton, California.



guidance subassembly modules which previously had taken 15-to-18 hours to complete were cut to nine hours of assembly time.[3]

It must be clearly understood that this was a performance aid rather than a learning aid application. The slide/tape presentation was, in effect, an audiovisual blueprint. The worker needed to know the assembly skills required for following that blueprint. The objective of the instructional program was improved production, not learning. At a time when the appearance of "teaching machines" was creating a considerable stir in educational circles, the industrial slide/tape performance aid was proving to be the perfect "non-teaching machine."[4]

Despite the limited objectives of the industrial performance aid programs, they were in fact the immediate developmental predecessors of the electronic assembly programmed learning system for the deaf. Industrial experience stimulated research into the use of learner-centered audiovisual techniques both as learning aids and as performance aids for the handicapped. The first impact on special education was not on education of the deaf, however, but on instruction for the mentally retarded.

Beginning in the early 1960's research began to establish that learner-centered audiovisual programs could substantially facilitate both learning and retention by retardates. It was demonstrated that synchronous slide/tape devices, providing individual instruction at the learners own pace, could significantly improve the learning of job skills.[5] Research projects also indicated that sound motion pictures[6] and 8mm film loops[7] could be effective for the vocational training of the mentally retarded.

In performance aid applications, it was demonstrated that industrial slide/tape techniques could be used successfully in sheltered workshop situations, both for the mentally retarded and other handicapped populations. Figure 6 shows a newspaper clipping describing one such application at Opportunities Unlimited, Inc., Long Island, New York.[8]

Meanwhile, research into picture-based, learner-centered instruction for the deaf was being focused on language learning and speech teaching. Experiments were indicating that programmed learning could be extremely effective in deaf education.[9] One outgrowth of this research was Project LIFE.

Figure 6. Newspaper Clipping: "Look, Listen & Learn, Audio-Visual Training."

The successful applications of learner-centered audiovisual instructic in industry, the use of industrial techniques for vocational training of the mentally retarded, and research into programmed learning for the deaf had laid the groundwork of feasibility. The early promise of Project LIFE provided final encouragement toward development of a programmed learning system for electronic assembly training.

SYSTEM DEVELOPMENT

Figure 7 depicts the sequence of procedures which were implemented for system development. The first phase consisted of an anaylsis of the electronic assembler's job to identify what specific skills, knowledge, and attitudes would have to be taught. This analysis was conducted through visits to both large and small electronics manufacturing plants, a review of existing instructional materials and training programs which appeared relevant, and a study of NASA, Department of Defense, and industrial work standards. The data derived resulted in the specification of learning objectives and program outlines.

This initial phase was conducted by Donald R. Robinson and J. Norman Swaton, two highly experienced instructional programmers with extensive backgrounds in technical training. Subject-matter expert during this and subsequent phases of development was Roger Taylor, quality assurance engineer, North American Aviation, Inc., Downey, California.

Lesson planning and initial lesson writing took place in 1967 during a six-week production workshop conducted by Mr. Robinson and Mr. Swaton, and attended by Henry R. Zink, electronic assembly instructor,

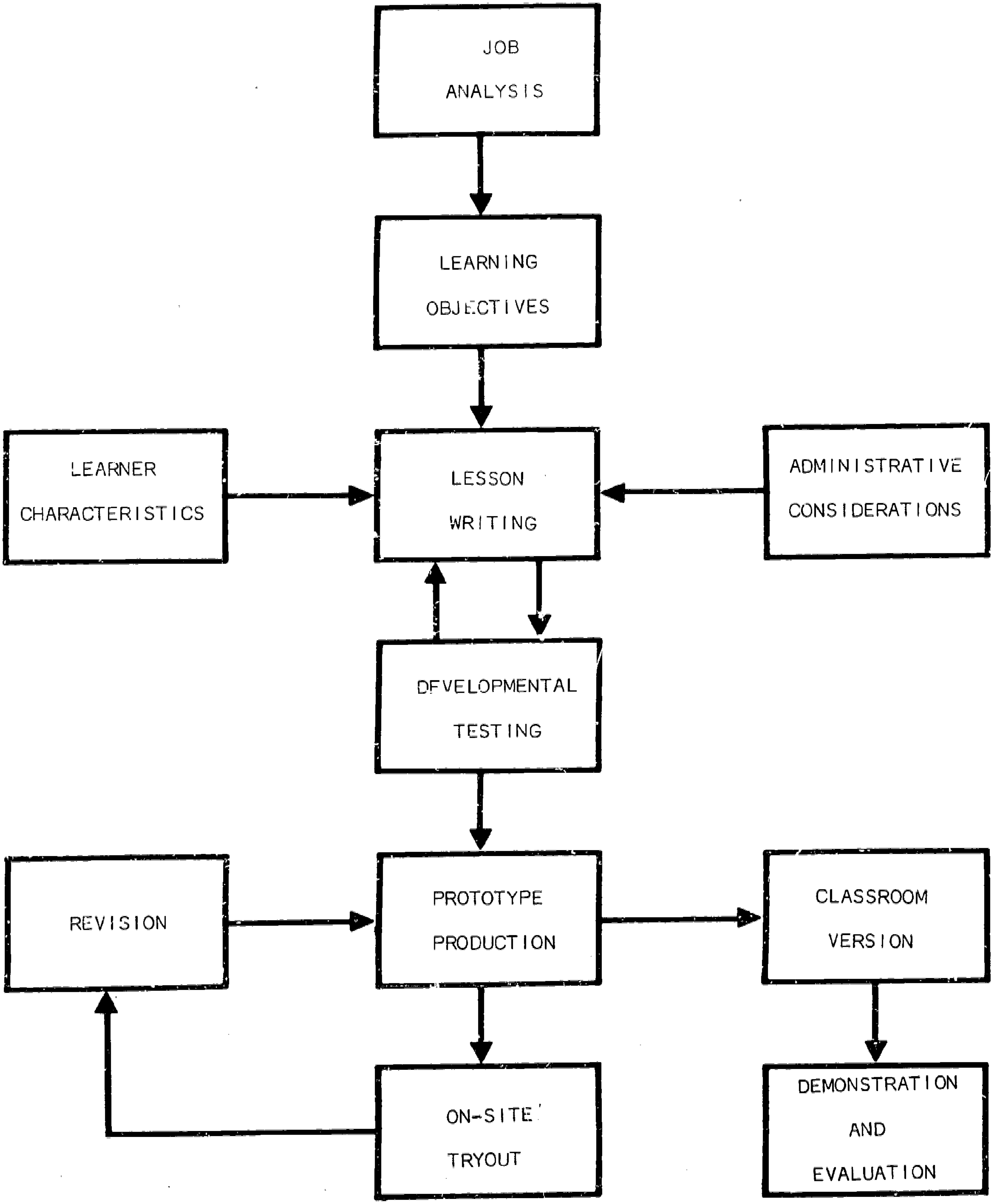


Figure 7. Procedural Model: Instructional System Development.

California School for the Deaf, Riverside; the late Harold Ramger, high school science instructor, California School for the Deaf, Berkeley; and John M. Fessant, supervising teacher of vocational education, Oregon School for the Deaf, Salem.

While producing tryout versions of the first three programs in the series, the three teachers of the deaf received intensive instruction in programmed learning techniques, while the two programmers learned about characteristics of deaf learners and the special nature of deaf education. Both learner characteristics and administrative considerations were taken into account in lesson writing.

Prototype slide and text materials for the first three programs were produced by Graphic Films Corporation, Hollywood, California. During the fall semester 1967, initial tryout activities began at the California Schools for the Deaf, Riverside and Berkeley, and the Oregon School for the Deaf, Salem. One electronic assembly workbench was set up at each of these schools, installed in the classrooms of the teachers who had participated in the production workshop. These teachers now began administering the programs and collecting tryout data.

During 1968, draft versions of the remaining four programs were completed and subjected to developmental testing by Mr. Robinson and Mr. Swaton, with Mr. Zink serving as consultant, and Dr. William Blea, coordinator of language and reading programs for Los Angeles City Schools, reviewing the programs for language and reading content.

Draft materials, at this point, consisted of black-and-white Polaroid prints mounted on the same page with programmed text frames ultimately intended to accompany the color transparencies which the Polaroid prints represented. Developmental testing consisted of administering these materials to a single carefully chosen trainee --- a representative high school student from the California School for the Deaf, Riverside. The trainee went through the entire course of instruction while being very closely monitored by the instructional programmer and consultants. The kind of data obtained was not intended for statistical analysis, but was for the purpose of exposing basic deficiencies in the curriculum before lesson plans were finalized and expensive prototype production work was begun.

Prototype slide and text materials for the last four programs in the series were produced by TRW Systems Group, Redondo Beach, California. Production began in January 1969 under the supervision of Ellen M. Howarth, TRW Systems' senior assembly instructor. During summer school 1969, tryout of the prototype version of the four programs was conducted at the California School for the Deaf, Riverside. Four completely equipped electronic assembly workbenches were installed, and tryout activities were administered, monitored, and evaluated by Miss Howarth and Mr. Zink. Figure 8 shows trainees at work during the tryout.

The remainder of 1969 and early 1970 were devoted to analysis of tryout data and the final revision of all seven programs. During development of the last four programs in the series, tryout of the first three programs had continued both at Riverside and at the single-workbench installations in Berkeley, conducted by Eric Malzkuhn, who had replaced Mr. Ramger; and in Salem, conducted by Roy Pleyler, replacing

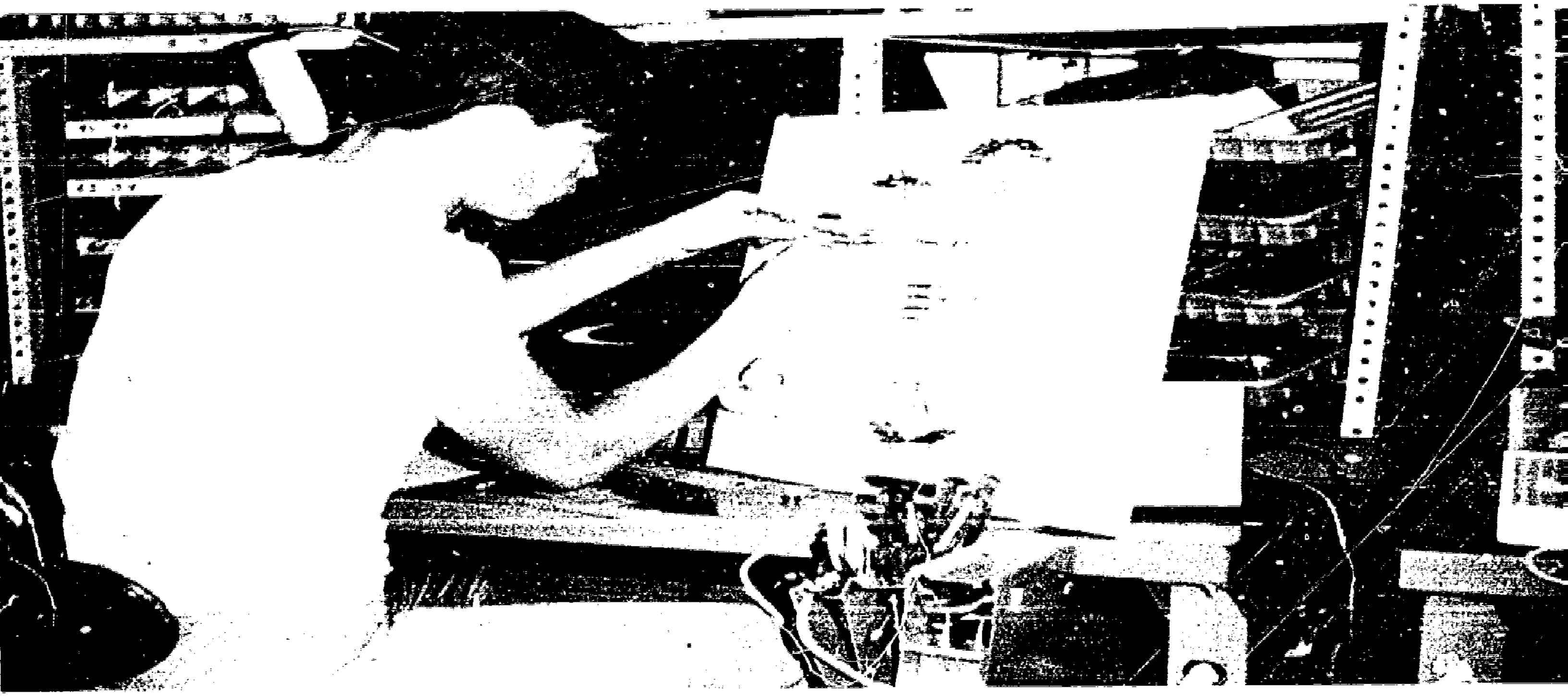


Figure 8. Trainees. California School for the Deaf, Riverside.

Mr. Fessant. Data from teachers' log books, programmed textbooks in which trainees had entered written responses, and interviews with both teachers and students were subjected to both item and statistical analysis.

Selected portions of the programs were subjected to a final session of developmental testing. Through the cooperation of Dr. Harry Murphy, principal of the Southwest Los Angeles County School for the Deaf, Lawndale, California, Polaroid-print materials were administered to a group of 13-and-14-year-old girls and boys with reading achievement at third- and fourth-grade levels. Under normal use of the curriculum, children of this age would never be accepted as trainees. The purpose of testing with them was to revise the reading level of the programs as far downward as possible. In striving toward this goal, important contributions were made by Dr. Blea in his continuing capacity of language and reading consultant.

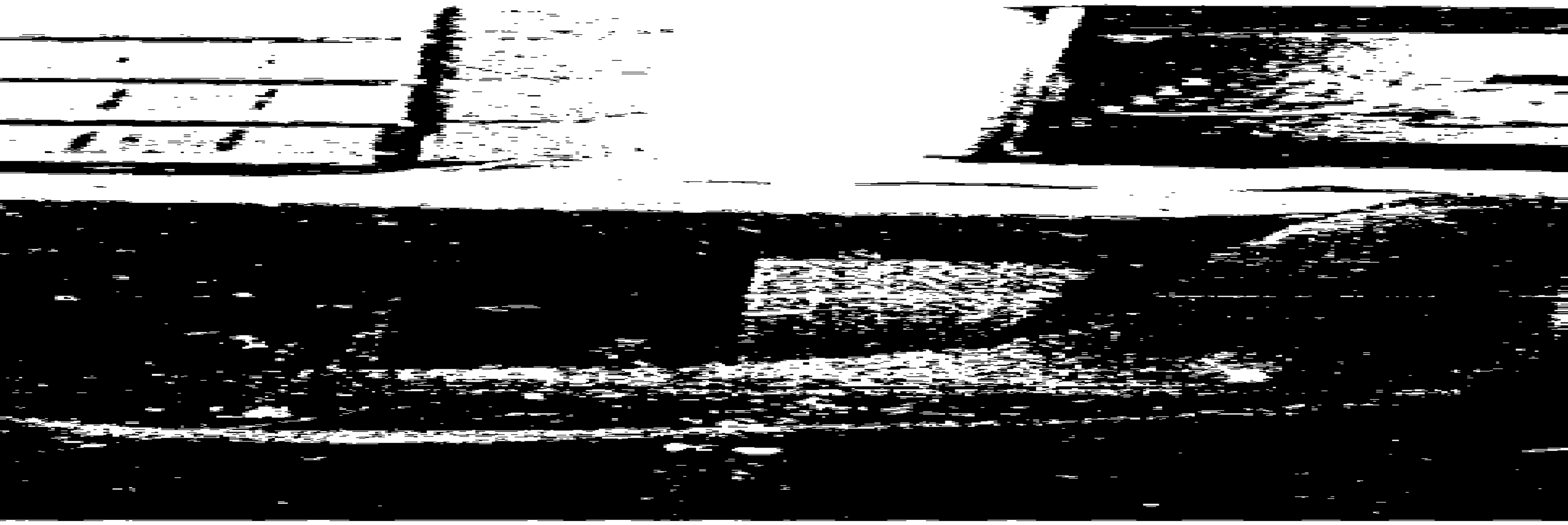
In the spring and early summer of 1970, the four demonstration and evaluation institutions were selected. With the beginning of school during the fall semester, a total of 24 workbenches were installed: eight workbenches at American School for the Deaf; six workbenches at California School for the Deaf, Berkeley; five at the Salem Rehabilitation Facility; and a fifth workbench added to the four already at California School for the Deaf, Riverside. The West Hartford, Berkeley, and Salem sites were provided with filmstrip projectors, while Riverside retained the slide projectors which had been used for tryout purposes.

Figure 9 shows the different types of workbenches and classroom arrangements at American School for the Deaf, where workbenches are installed against opposite walls of the classroom, and at California School for the Deaf, Berkeley, where workbenches are installed back-to-back. One of the design objectives of the instructional system was that all electronic assembly and filmstrip projection hardware should be on-the-shelf and readily available from retail dealers. This objective was met. No special equipment of any kind was created for the system. Different types of workbenches and workbench accessories may be used, as long as they meet functional specifications.

INSTRUCTIONAL AND ADMINISTRATIVE EFFECTIVENESS

Because actual instruction at the demonstration and evaluation sites did not start until well after the beginning of the fall semester 1970, insufficient evidence exists from this phase of the project to draw substantial conclusions. However, during the developmental testing and on-site tryout of prototype materials, approximately 85 deaf and hard-of-hearing boys and girls completed all or at least part of the series of seven instructional programs. The discussion which follows is based on performance data accumulated both during developmental testing and on-site tryout and during system administration to date at the demonstration and evaluation sites.

Overall experience indicates that the system is both instructionally effective and economical: a workbench can be installed, complete with electronic assembly gear and filmstrip projector and screen



Top: American S
ecticut. Bottom
erkeley.

for approximately $1,000.00. Multiple installations will cost less because of volume discounts. The cost of expendables for each trainee can be less than $35.

As shown in Figure 10, deaf trainees of normal intelligence, but with reading grade levels as low as 3.5 have successfully completed the course of instruction and met the specified performance objectives. Average time for completing instruction is approximately 100 hours, with individual completion times ranging from 50 hours or less to 200 hours or more.

Length of individual instruction periods appears to be an important variable in instructional effectiveness. Both the speed and quality of the trainees' work tend to increase with longer instructional periods. No problems exist in holding the trainees' interest and keeping them at their workbenches for periods as long as three hours, given the opportunity for a midway break.

An important administrative consideration is what to do in group instruction with the fast learner who finishes early. A number of choices exist. The fast learner might serve as an assistant to the teacher in handling administrative details or serving as a peer tutor. The fast learner also might be given assembly projects to reinforce what he has learned with further work experience, and to assure his ability to transfer what he has learned to work situations which are not identical to his learning experience.

ELECTRONIC ASSEMBLY

Tryout of Self-Instructional Programs 4-through-7

California School for the Deaf, Riverside, California

June 16 through July 25, 1969

BEHAVIORAL AND ACHIEVEMENT DATA

WORK-MANSHIP	STUDENT	AGE	GRADE	WEXLER I.Q.	GRAY-VOTAW-ROGERS LANG.	GRAY-VOTAW-ROGERS READING VOCAB.	GRAY-VOTAW-ROGERS READING COMP.	ELECTRONIC ASSEMBLY PROGRAMS AVERAGE HOURS PER PROGRAM	ELECTRONIC ASSEMBLY PROGRAMS EXAM SCORES (MEAN)
1	Lance Y.	17-7	9	91	5.6	4.8	5.9	7.8	95.5%
2	Mark S.	16-6	9	120	6.8	5.3	4.9	6 6	91.7
2	Geraldine L.	17-2	10	---	3.5	4.1	4.0	8.8	87.7
3	Robert B.	17-11	9	117	4.3	3.5	4.2	9.0	88.0
4	Ken S.	16-2	8	109	4.1	4.8	6.8	7.1	90.5
5	Sharon I.	15-8	9	100	4.3	5.0	4.9	13.2	88.5
6	Joanne M.	17-6	9	87	3.4	4.4	3.5	13.0	64.0

Figure 10. Behavioral and Achievement Data: Tryout of Programs 4-through-7.

may be
Figure
for thi
were qu
Nonethe
signifi
practic

F

Ideal assembly projects for the trainee who finishes early e found among commerically available electronic assembly kits. e 11 shows one such trainee assembling a capacitor tester. The kit his project contained a chassis, parts, and assembly drawings which quite different from those used in the instructional program. theless, the trainee was able to complete the assembly with no ficant problems, and the capacitor tester subsequently was put to tical use as workshop equipment.

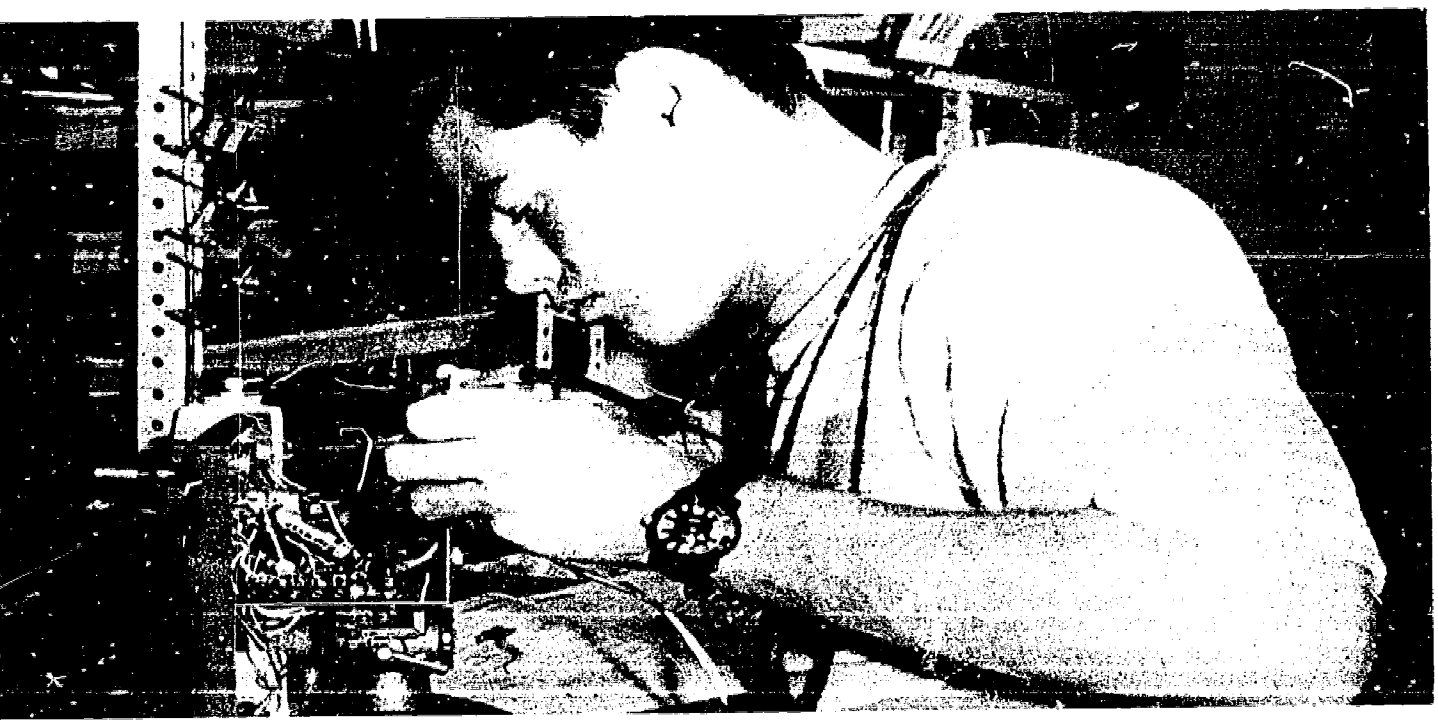


Figure 11. Trainee. California School for the Deaf, Riverside.

The instructional system appears to be both flexible and adaptive to individual learning styles. In multiple-workbench situations, some trainees tend to ignore one another completely while others monitor their neighbors' work, compare workmanship, and sometimes discuss the instruction. Pairs of trainees at adjacent workbenches often pace each other, not trying to outdo one another, but carefully keeping abreast. Others will compete.

One consistent characteristic has been the spontaneous emergence of peer-tutor relationships between trainees (Figure 12). Slower learners needing help tend to turn to those who are proceeding faster and doing better. The faster trainees appear to enjoy the role of tutor, and typically do an effective job.

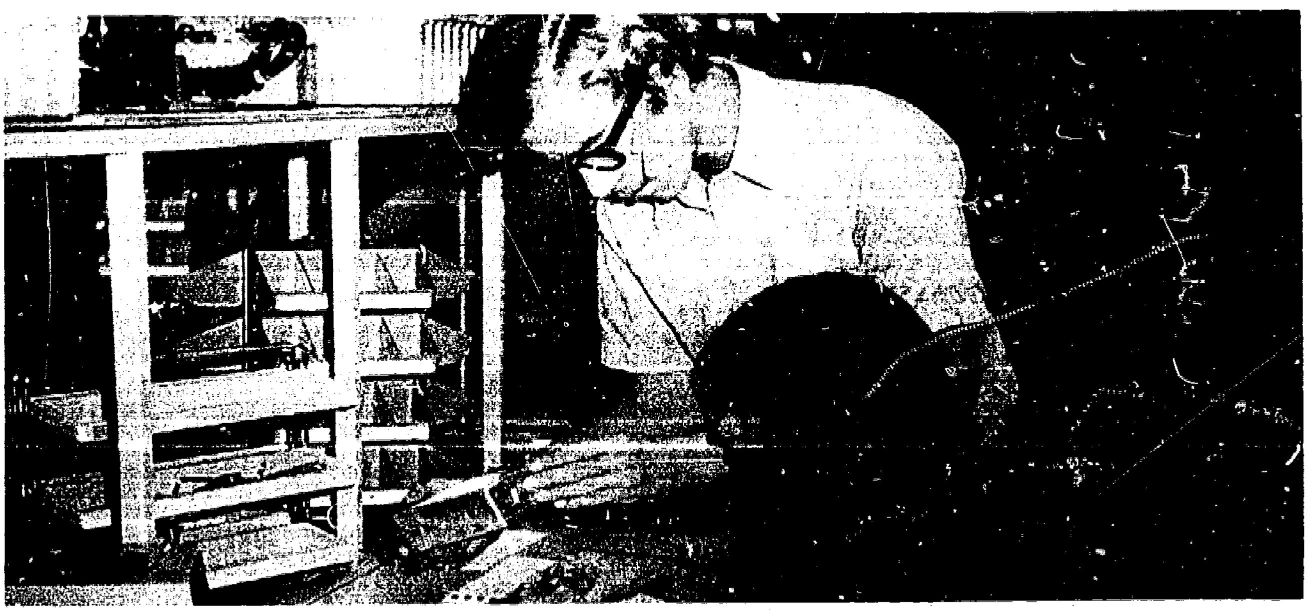


Figure 12. Trainee Peer-Tutor Activity. California School for the Deaf, Berkeley.

The system tends to be highly motivating. There have been no indications of Hawthorne effect --- interest in the course has not diminished as the novelty wears off. To the contrary, interest has tended to increase as the trainee moves from program to program, advancing to increasingly more complex aspects of the electronic assembler's job, learning to use new tools, perfecting the skills he is learning, gaining increased confidence in his ability to follow technical instructions and do exactly what is required, and having the satisfaction of actually <u>building</u> something.

Substantial improvements in reading ability, language skills, and study habits have been noted on the part of those trainees completing the curriculum. Because improvement of reading and language skills was not a specific objective of the development project, no statistical data have been accumulated to show this improvement. Of necessity, however, in order to complete the instructional programs a trainee must learn to read instructions carefully, to interpret them precisely, and to follow them exactly.

Because programmed learning materials bear the burden of communication and instruction, the classroom instructor need not be an experienced teacher of the deaf. In fact, experience to date indicates that the best instructor is an experienced electronic assembler, assembly supervisor, or electronic technician.

All of the teachers at the four demonstration and evaluation sites were newly hired for the fall 1970 semester. None of them had previous experience in deaf education or in communicating with the deaf. All of them had experience in electronics, however: Paul Rakyta came to American School for the Deaf directly from 25 years in the electronics industry; Sam Nolan is a 25-year retired veteran of Naval electronics who came to California School for the Deaf, Berkeley, directly from a job as an electronic technician in a government research laboratory.

Gerald Peterson, instructor at California School for the Deaf, Riverside, is a recent college graduate in education with electronic experience both in the Navy and in industry; Josephine Copple, at the Salem Rehabilitation Facility, previously had instructed and supervised electronic assembly subcontract work at the Facility's sheltered workshop.

To date, no major problems in administration have emerged at the demonstration and evaluation sites. It appears evident that an experienced teacher should be able to supervise the work of at least 10 trainees, each at his own workbench. But it also is evident that no matter how few workbenches are occupied, administration of the system is a full-time job.

The trainee always must be able to find tools, parts, and materials exactly where they are supposed to be on the workbench at the moment he needs them. Making sure that everything is where it is supposed to be is an important part of the teacher's job. In addition, although the teacher's attention may be required no more than 10 per cent of an individual trainee's time, the teacher always must be available when the trainee needs him.

The system appears to be applicable to other populations than the deaf. The self-pacing feature makes it highly attractive for mixed groups with individual learning differences. Because it does not require a high level of reading skill, and because of its self-motivating aspects, the system may well serve a broad range of handicapped and retarded learners in both schools and rehabilitation settings. All of this remains to be determined, however.

What is clear at present is that the system works for the population for which it was intended --- deaf high school students. It lends itself to practical application in operational school settings. It results in learning. And as reflected in Figure 13, the learner appears to enjoy the experience.

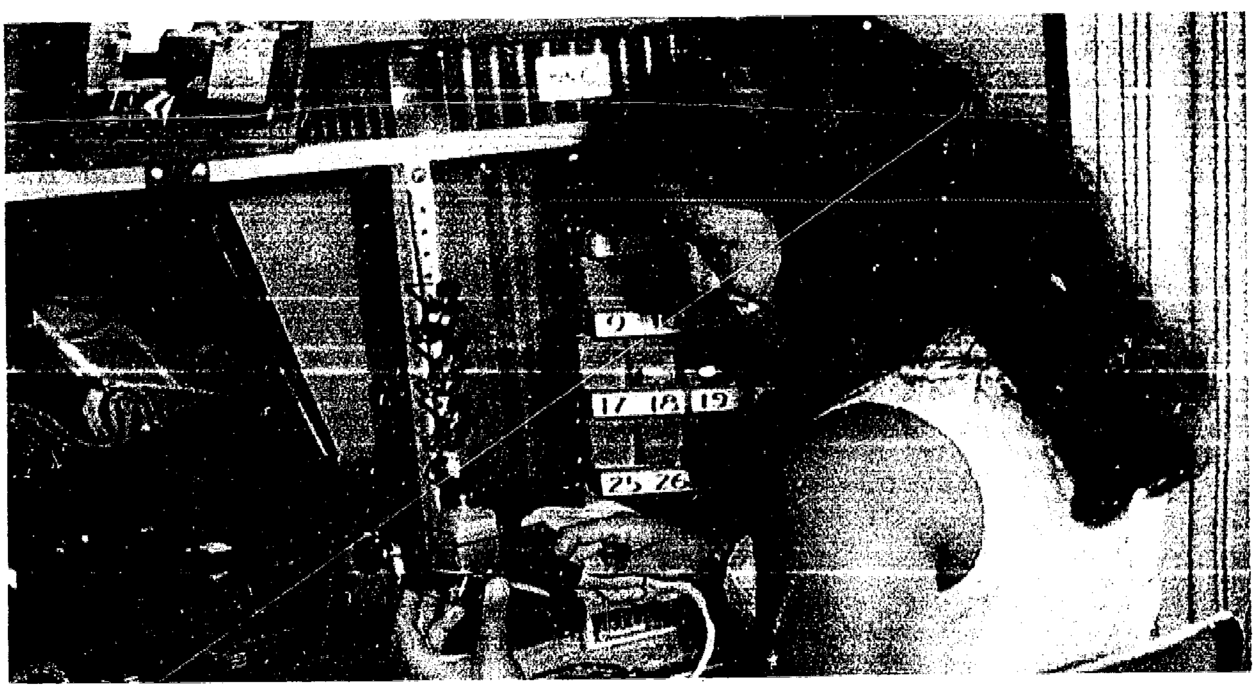


Figure 13. Trainee. California School for the Deaf, Riverside.

REFERENCES

1. Brooker, Floyde E. Training Films for Industry: Final Report on the War Training Program of the Division of Visual Aids for War Training. Bulletin No. 13. Washington, D. C.: Federal Security Agency, U. S. Office of Education, 1946. p. 103.

2. Persselin, Leo E. An Approach to System Design in Audiovisual Instruction. Ph.D. dissertation, University Microfilms Order #68-5878, University of Southern California, 1967. p. 609, See "Audio-visual Instructional Systems in Industry," pp. 238-283, for an extensive discussion of the Hughes and other industrial and vocational instructional systems applications; also "A Training System for Industry," pp. 481-504, for a more elaborate description and evaluation of the War Training Program of the Division of Visual Aids for War Training.

3. "Color-Sound Slides Speed Assembly," American Machinist/Metalworking Manufacturing, April 30, 1962, pp. 108-110.

4. Persselin, Leo E. "Auto-Instructional Technology and Data Processing," Data Processing for Management, VI, No. 4, April 1964, pp. 9-12.

5. Neuhaus, E. C. "Programmed Audio-Visual Training for the Mentally Retarded," Trends in Programmed Instruction. Edited by Gabriel D. Ofiesh and Wesley C. Meierhenry. Washington, D. C.: National Education Association, 1964. pp. 98-100.

6. Goldstein, Edward. Selective Audio-Visual Instruction for Mentally Retarded Pupils. Springfield, Ill.: Charles C. Thomas Company, 1964. p. 96.

7. Bitter, James A., and Bolanovich, Daniel J. "Job Training of Retardates Using 8mm Film Loops," Audiovidual Instruction, XI, No. 9, November, 1966, pp. 731-732.

8. "Look, Listen & Learn, Audio-Visual Training," Long Island Commercial Review, Garden City, L.I., N.Y., May 8, 1963.

9. Beckmeyer, T. "Application of Programmed Instruction to Remedial Reading for the Deaf," Volta Review, LXV, 1963, pp. 415-417; Falconer, G.A. "A Mechanical Device for Teaching Word Recognition to Young Deaf Children." Doctoral dissertation, University of Illinois, 1959; Fehr, J. "Programming Language for Deaf Children," Volta Review, LVIV, 1962, pp. 14-21; Karlsen, B. "Teaching Beginning Reading to Hearing Impaired Children, Using a Visual Method and Teaching Machines," University of Minnesota, U.S. Office of Education Project No. 1204, 1966; etc.

The activities reported herein were performed pursuant to a contract with the United States Department of Health, Education, and Welfare: Office of Education, Media Services and Captioned Films, Bureau of Education for the Handicapped.

"The learr is a person who wants something;
The learner is a person who notices something;
The learner is a person who does something;
The learner is a person who gets something."

Succinct and direct, this quote by J.R. Kidd in How Adults Learn capsulizes the challenge in education. When considering the deaf learner, its application is even more poignant. Notice the quote's use of active verbs. Learning means change. Change in student knowledge. Programmed instruction is one means to this end. However, paramount in Symposium discussion sessions was reiteration that the teacher is still the key to successful change in learning. Programmed instruction is only one possible solution. The teacher is the real answer.

The School, the Teacher, the Student and PI

The teacher who uses programmed instruction as a learning tool cannot succeed however, without the ardent support of two related factions. One is the school administration; the other is the students.

Teacher/demonstrators who showed various utilizations of PI at the Symposium made note that their administrations were strongly behind the idea. Administrators, also on the Symposium program, during discussions urged other administrative personnel to encourage staff members to be creative regarding PI. They have found that teachers generate enthusiasm among themselves and the whole development of a PI program mushrooms. Furthermore, programmed instruction must be curriculum oriented and this means that teachers and administrators must work together to achieve learning objectives. Discussion also raised and supported the idea that students be directly involved in determining goals for programs.

Pursuing this determining of goals one step more, it was felt that if only teachers were involved in setting behavioral objectives, that these objectives would tend to be based on what teachers think they can teach ... not on what students can learn. The conclusion was to put children on already valid programs and observe their achievement. Then generalize achievement levels from what students do, not what teachers think students will do. Schools should also strive to get teachers from all levels in each subject area working together on programmed materials.

The cost of programming instruction quite naturally made its appearance in the discussions. More than one speaker emphasized what can be done by teachers who have a little bit of knowledge in programming, yet, who can make inexpensive, effective materials. It all starts with pencil and paper many said. Even small schools with limited budgets were encouraged to get involved. Parents, in various speakers' schools, have also helped. Expensive programmed materials or machines are not the answer to improved acquisition of knowledge. If you can't afford something, make an adaption to fit your needs. A perfect example of this premise was shown by Dr. Harry Murphy. In his demonstration he showed use of The Learning Wall, a rear screen projection device used to teach children body parts, etc. He noted the commercially produced product cost $270. Or you can make one for $20.

The Symposium audience felt that the Oregon School for the Deaf program was quite indicative of good preparation for individualized learning. It was noted by participants that their program allows for individuality plus the school has established a place for the collecting and using of materials. Their utilization of commercially produced programs made a rememberable point with the participants. The finding of commercially made programs and their evaluation for the population target that needed specific instruction had its impact with those in the audience. Participants felt strongly enough about the Oregon School program that they suggested that the school gather follow-up data on their school-leavers for feedback information relative to an on-going program.

Symposium participants found it greatly informative to quiz the demonstrating teachers on their specific classroom experiences with programmed instruction. In trying to pinpoint how much of a day must be given to individual PI work, one teacher said that she had tried writing and using it in a one and one (teacher and student) situation. This did not work. She then tried two to one, three to one and then larger unit The time factor greatly hindered productivity. For that reason she suggested that materials should be made up for large groups. Individualized instruction does not mean one teacher working with one student but any number of students working in a room but on their own individual materials at their own pace.

In an effort to solve the perpetuating "no time" problem in producing programming it was suggested that para-professionals or students be used to assist in making programs. Or possibly a full-time programmer for a school. However, it was emphasized that the teacher remains the integral part in programming. A participant noted that Mrs. Joan Tellam used programming in her school to help a child with a specific problem. This seemed to be a rather unique consideration for programming which isn't generally brought to attention; that the principles of programmed learning in a programmed set of materials can be devised and used to help a particular child over a needed learning hurdle so that he can continue with his learning process. First hand knowledge of the learner might prove to be significant in terms of writing a program for that specific person's needs. So no one solution was reached as being the source of programmed instruction. The need helps dictate the source.

Not only teacher/administration attitudes but student attitudes was mentioned as a key to PI success. There is no doubt that Mr. Peter Pipe generated a good deal of interest and concern in the real PI consumer. His interest in student attitudes as against that of the cognitive and psychomotor learning in PI was well received by participants. The point was made of doing experimentation with PI materials preceding elaborate formulation of theories. Programmers, if they really wish to focus on the student's needs, should view the learning process as students work through a variety of actual programs. By observing more and theorizing less about hypothesized affects, the real needs of the student can not only be pinpointed but served. Of what is the benefit, if a child learns a skill or subject matter very well but ends up despising it? Programmed instruction can be overly dull if the program writer isn't careful about introducing those things that make learning relevant, challenging and meaningful.

Establishing Programmed Instruction

Before programmed instruction can be utilized in a meaningful way, education of the deaf logically needs more informed practitioners. Participant discussion indicated that primary needs include extensive training including short-term workshops, formal university courses and summer institutes as well as local orientation sessions for the entire staffs of schools for the deaf. In residential school this should include domestic as well as instructional staff and should also include parents whenever possible.

With minimal training provided, a start can be made. A plea was forwarded for teacher release time from teaching responsibilities to then produce programs. Or possibly when teachers have a sufficient PI background the school could employ special personnel to do work on the production and testing of materials. In those situations where a special production person or staff is provided, close liason between teachers and programmers is essential. Strong administrative leadership was identified as a basic requirement in maintaining a balance of input so that programmers are implementors but not determiners of curriculum.

In utilizing PI, one of the most important factors pointed out was the initial understanding then subsequent application of basic programming principles. This implies the ability to make suitable statements of behavioral objectives and subsequent development of effective frames leading sequentially to the achievement of these objectives. Bibliographies on these essential aspects of programming are available from the Southwest Regional Media Center for the Deaf, Las Cruces, New Mexico. Also available at the SWRMCD is a six-week summer institute devoted solely to programmed instruction.

Participants scrutinized with deep interest the program in Educational Technology conducted by Dr. Donald Torr of Gallaudet College. An integral part of this course, the audience noted, was the use of PI as one of many teaching tools. Not only is the course organized on an individualized instruction basis, but all projects developed by students are formulated with individualization as their main objective. The idea of persons graduating from college with a sound background in programming as an understood part of educational technology appealed to the participants.

Two Notable Varieties of PI: Project LIFE and Computer Assisted Instruction

The unanimous acceptance of Project LIFE materials in various schools was obvious. "The materials work" as one person wrote. Major interest during the Symposium focused on the availability of additional Project LIFE programs. The answer was stated quite clearly. Project LIFE has had meetings with various industries and subsequently the hardware and software programs should be available by this summer (1971) or at least before school starts next fall. Available validated materials will total 180 filmstrips by the fall of 1971. The Project LIFE staff said that 300 such filmstrips would be ready for use in the fall of 1972. It was also pointed out that Project LIFE will provide in-service training for use of the materials and that it would be made available so that anyone interested can purchase them.

One of the public school teachers pointed out that money was tight and they could not afford the hardware or software. She suggested that Project LIFE sell the hardware and software to other than deaf groups and then supply the deaf groups free. The Project LIFE people seemed to think it was a good idea and asked that anyone who felt the same way should write Project LIFE about their thoughts.

When participants considered computer assisted instruction, the questions of installation, cost, time scheduling and the overall effectiveness seemed to dim the immediate potential of this method of instruction. CAI seemed a far piece down the instructional road compared to where we are today.

Undoubtedly, such people as Dr. Patrick Suppes are interested in developing the computer to the place where it will be able to handle the syntax of a language of a culture. There's no doubt that Symposium participants are also awaiting such a breakthrough. While the computer is a very useful educational tool in areas of learning such as mathematics, it will be an even greater learning device if the computer learns to handle language as people generally use it. The computer program, it was pointed out, is not intended to do all of the teaching. Again, it is the teacher who prepares the student and the computer is supplementary.

Programmed Electronic Assembly

The system of programmed electronic assembly demonstrated by Dr. Leo Persselin was enthusiastically received by participants. A few of the most important features of Dr. Persselin's program, outside the fact that it really meets their objectives, is the "aside" and informal information that in considering student attitudes there appears to be a great deal of carryover of notable improvement in classroom participation among those trainees who were involved in the electronic assembly programmed learning system. Plus there are good indications that industry is indeed very much interested in this training program for the deaf. Participants seemed to like the concreteness of this type of programming. They knew the objectives, saw the system working and could see the measurable, tangible results. Something which is hard to isolate in much PI utilization.

In answering participant questions, Dr. Persselin said that this system does not teach electronic theory. It teaches what is necessary to obtain and retain a job. That criteria is skill. This system teaches a range of skills that covers more than would be taught ordinarily. By teaching seven skill areas, this system has attempted to make the deaf person so good they will be hired. Examples of industries which might be interested in these graduates would include manufacturers of electric lamps, aircraft, electric irons, telephones, etc. The direct application of a subject learned via PI to an immediately usable trade greatly appealed to the audience.

PI Clearinghouse

The dissemination of existing PI materials expressed itself with reoccurring persistence. Dissemination by participant definition took two forms. One was the idea of making available validated materials effective in different research activities accessible to all teachers. Many participants felt that administrators were attending most of the conferences, getting most of the journals and coming in contact with important research materials. The second type of dissemination concerned the actual accumulation, storing and reproduction of programs for distribution.

The Southwest Regional Media Center for the Deaf was named as the logical coordinator of these activities. Participants also pointed out there should be some central coordination of programming across the U.S. to alleviate needless duplication of effort. The clearinghouse concept would also be involved in the exchange of PI materials between various schools. Another idea forwarded was that of having this clearinghouse circulate a regular publication containing abstracts or information on new projects, etc. Persons from the SWRMCD stated that their catalog of programs is now at 80 and there are 40 more now available.

Evaluation

Evaluation of programmed materials for the deaf was a reoccurring subject for questions and discussion. Two concepts of evaluation were in evidence. The first was controlled experimentation yielding numerical data that will "prove" the effectiveness of a particular item or set of materials. A second and more pragmatic approach might be summarized by the question, "Are the users learning anything?" as determined by standardized or other tests. At the present stage of development there appears to be little of the first type of evaluation but a substantial amount of the latter.

Several persons made the point that perfection as to appearance and reliability of PI materials are not really necessary and may be far too expensive. More important are the selection of relevant objectives and the development or selection of materials that will help the student to progress step by step toward those objectives. Unstated, but implied, there seemed to be a concept that the process of working in a programmatic manner helps to redefine the role of teacher and learner, restructuring the learning process from its traditional "master and servant" format to one of a sense of partnership between teacher and pupil. If indeed, this change in basic educational philosophy is the underlying strength of PI it may explain why some educators are pushing forward eagerly in this field without waiting for the tedious and stultifying evaluation exercise of formal, controlled research. In fact, with the rapid rate of change in today's society, and hence, curriculum, extreme caution may be the surest way to lose the ball game.

Peter Pipe made a point with participants when he emphasized the importance of not being carried away with validation procedures. He noted that it is better to take a program and try it than to sit around and wait for a perfect one to come along. There is a value of keeping programs small and discreet so they can be changed easily.

Participants noted the reoccurring pressure to give hard and fast data concerning PI in the classroom. Pipe stated that statisticians say programs have to be perfect for 40 or more students. He suggests 12 or so is enough to get moving. Talk it over with three fairly typical students, then, three more, etc. When you're doing developmental testing, when you are revising, ask the children for reactions. Then perform field testing for final confirmation.

Several participants expressed interest in various larger outcomes of PI such as stimulation and improvement of independent reading, motivation, sustained interest on the part of the learner, interpersonal relationships and the ability to do independent thinking. The consensus seemed to be that since PI was more supplemental than central to existing educational programs, the specific contribution of programming to these general objectives would be difficult if not impossible to isolate. But, as one exponent of programming expressed it, "We feel good about it."

Dr. John Gough, a Symposium discussion recorder, seemed to summarize well the plight of programmed instruction. To the observer who is aware of the deep struggle within American education between the forces of conformity as opposed to proponents of individuality and unique personal development, the question arises whether PI is in fact but a supplementary aspect of the total educational picture. Or, admitting this to be a fact, is it true that programmed and individualized instruction is destined to remain in the secondary role? There are those who see it as the beginning of an educational revolution that will ultimately break the present iron grip of a system which, despite protestations of freedom and democracy, hold to authoritarianism as its primary tenant with passiveness and obedience as the essential educational objectives. In groping for light and assistance within this dark enclosure, symposium participants seemed to be reaching out eagerly and hopefully. Whether or not those hopes will be fulfilled remains for the future to disclose.

SYMPOSIUM

on

RESEARCH AND UTILIZATION OF EDUCATIONAL MEDIA FOR TEACHING THE DEAF

"Programmed Learning for the Deaf Student"

National Conference
Sponsored by the

UNIVERSITY OF NEBRASKA
TEACHERS COLLEGE
DEPARTMENT OF EDUCATION ADMINISTRATION
MIDWEST REGIONAL MEDIA CENTER FOR THE DEAF
SOUTHWEST REGIONAL MEDIA CENTER FOR THE DEAF
PROJECT LIFE

THE NEBRASKA CENTER FOR CONTINUING EDUCATION

Lincoln, Nebraska

March 22 - 24, 1971

Support for this conference has been provided by a grant from Media Services and Captioned Films for the Deaf, Bureau of Education for the Handicapped, U. S. Office of Education, Department of Health, Education and Welfare, Washington, D. C. 20202.

Monday...March 22, 1971

1:00 p.m.	Registration, and Coffee, Conference Lobby
2:00 - 4:30 p.m.	General Session I Southwest Regional Media Center for the Deaf Dr. Hugh Summers, Director Mr. Ramon Rodrigeuz Mr. Robert M. Edwards Project LIFE Dr. Glenn Pfau, Director Mr. Charles Zerrip Mrs. Waunita Garner National Technical Institute for the Deaf (NTID) Dr. O. Dennis Barnes, Director
6:00 p.m.	Social Hour, Cornhusker Hotel
7:00 p.m.	Banquet, Cornhusker Hotel General Session II Keynote Speaker: Dr. Edgar Lowell, Administrator John Tracy Clinic Topic: "Programmed Learning: Its Implication for the Deaf Student"

<u>Tuesday...March 23, 1971</u>

8:15 a.m. General Session III

Presenters: Dr. Edgar Lowell, Administrator
John Tracy Clinic

Topic: "Programmed Learning: Its Implication for the Deaf Student"

Mr. James McCarr
Oregon State School for the Deaf

Topic: "Programmed Instruction in a School Curriculum"

Dr. Harry J. Murphy, Principal
Southwest School for the Deaf

Topic: "Activities in Programmed Instruction at the Southwest School for the Deaf"

9:45 a.m.	Coffee, Conference Lobby
10:00 a.m.	Discussion Session I
11:45 a.m.	Luncheon
	General Session IV
	Keynote Speaker: Dr. Peter Pipe Senior Associate of Pipe and Associates Topic: "New Direction in Programmed Learning"
1:15 p.m.	General Session V
	Presenters: Elaine Costello, M.S. Instructional Programmer Callier Hearing and Speech Center Topic: "Programmed Learning at Callier Hearing and Speech Center"
	Helen Ross Sewell, Programmer Texas School for the Deaf Topic: "Specialized Methods for Teaching Communication Skills"

Joan Tellam
Arizona School for the Deaf

Topic: "Programmed Instruction for Young Deaf Children"

2:45 p.m. Coffee, Conference Lobby

3:00 p.m. Discussion Session II

6:30 p.m. Banquet, Omaha Room, Nebraska Center

General Session VI

Keynote Speaker: Dr. Patrick Suppes
Institute for Mathematical Studies
In the Social Sciences
Stanford University

Topic: "Computer-Assisted Instruction for Deaf Students"

Wednesday...March 24, 1971

8:30 a.m. General Session VII

Presenters: Dr. Donald Torr, Director
Office of Educational Technology
Gallaudet College

Topic: "A Graduate Course in Educational Technology"

Dr. Leo E. Persselin, Project Director
Electronic Assembly Programmed Learning System

Topic: "Electronic Assembly Programmed Learning System for the Deaf"

9:30 a.m.	Coffee, Conference Lobby
9:45 a.m.	Discussion Session III
11:45 a.m.	Luncheon, Omaha Room, Nebraska Center
12:30 p.m.	General Session VIII Summary Reports Media Services and Captioned Films Report Dr. Gilbert Delgado
1:30 p.m.	Adjourn

Mrs. Carrie Lou Abbott
Texas School for the Deaf
1102 South Congress Avenue
Austin, Texas 78704

Mr. James C. Achtzehn, Jr.
Syracuse University
123 College Place
Syracuse, New York 13210

Mr. Wayne Adams
University of Northern Colorado
School of Special Education
Greeley, Colorado 80631

Ms. Edna P. Adler
Rehabilitation Services Administration
Department of Health, Education and Welfare
330 C Street, S.W. Room 3316
Washington, D. C. 20201

Mrs. Ann H. Aldridge
North Carolina School for the Deaf
Joiner Hall
Highway 64, South
Morganton, North Carolina 28655

Miss Adoracion Alvarez
North Dakota School for the Deaf
Devils Lake, North Dakota 58301

Lloyd Anderson
Mill Neck Manor--Lutheran School for the Deaf
P. O. Box 12
Mill Neck, New York 11765

Mr. Norman O. Anderson, Director
Wyoming School for the Deaf
539 Payne Avenue
Casper, Wyoming 82601

Mr. Robert Anderson
Illinois School for the Deaf
125 Webster Avenue
Jacksonville, Illinois 62650

Mr. Roy Anderson, Coord. of Speech & Hearing
St. Joseph County Intermediate School District
P. O. Box 187
Centreville, Michigan 49032

Mrs. Paula Archer
Sunshine Cottage School for
Deaf Children
103 Tuleta Drive
San Antonio, Texas 78212

Dr. Aaron Armfield, Chairman
Special Education
University of Nebraska at Omaha
Omaha, Nebraska 68132

Mr. John Bachman
St. Paul Technical-Vocational Program
for Deaf Students
235 Marshall Avenue
St. Paul, Minnesota 55102

Mrs. Bette Baldis, Supervising Teacher
Lincoln-Irving School
1015--16th Avenue
Moline, Illinois 60525

Mr. Richard L. Baldwin
Hearing and Speech Department--
University of Kansas Medical Center
Olathe Boulevard
Kansas City, Kansas 66103

Dr. O. Dennis Barnes
Director of Computer Assisted Instruction
National Technical Institute for the Deaf
Rochester Institute of Technology
1 Lomb Memorial Drive
Rochester, New York 14623

Mr. David Barr
Northeast Regional Media Center
AV Center--Thompson Hall
University of Massachusetts
Amherst, Massachusetts 01003

Mrs. Carol Beckman
Model Secondary School for the Deaf
Kendall School--Gallaudet College
7th and Florida Avenues, N. E.
Washington, D. C. 20002

Sister Anne Behre, Superintendent
St. Francis DeSales School for the Deaf
697 Carroll Street
Brooklyn, New York 11215

Dr. Carl A. Binnie
Audiology and Speech Sciences
Heavilon Hall
Purdue University
West Lafayette, Indiana 47907

Miss Mary A. Blair
Michigan State Department of Education
Division of Special Education
P. O. Box 420
Lansing, Michigan 48902

Mrs. Barbara Bodner
Jamesville, New York

Sister Mary Carl Boland, C.S.J.
Supervisor, Teacher Training Program
Boston School for the Deaf
800 North Main Street
Randolph, Massachusetts 02368

Mrs. Burl Bolesta
Robert McCord Oral School
4016 Estrella
P.O. Box 10934
Tampa, Florida 33609

Miss Janet Bourne, Director
Media Center
Nebraska School for the Deaf
3223 North 45th Street
Omaha, Nebraska 68104

Mr. Daniel Brewer
Berrien County Day Program for the Deaf
Berrien Springs, Michigan 49103

Miss Frances (Betsey) Brooke, Media Specialist
Southwest Regional Media Center for the Deaf
P. O. Box 3AW
University Park Branch
Las Cruces, New Mexico 88001

Miss Katherine Bruton
Kansas School for the Deaf
450 East Park Street
Olathe, Kansas 66061

Mr. Frank Bryan, Coord. of Elementary Department
Gallaudet College--Kendall School
7th and Florida Avenues, N.E.
Washington, D. C. 20002

Mr. John W. Butler
Syracuse University
Syracuse, New York 13210

Mr. Lewis D. Butler
Southern Regional Media Center for the Deaf
1812 Lake Street
University of Tennessee
Knoxville, Tennessee 37916

Miss Lois Byers, Teacher Consultant
Alexander Graham Bell Elementary School
3730 North Oakley
Chicago, Illinois 60618

Mrs. Doris Caldwell, Assistant to the Director
Southern Regional Media Center for the Deaf
1812 Lake Street
University of Tennessee
Knoxville, Tennessee 37916

Miss Lucy Caldwell, Principal
Kennedy School for the Deaf
240 Wyoming Street
Dayton, Ohio 45409

Sister Helen Callahan
Boston School for the Deaf
800 North Main Street
Randolph, Massachusetts 02368

Mrs. Mary Campbell, Supervisor
Deaf and Hard of Hearing Program
for Monroe County
Ida Public Schools
Ida, Michigan 48140

Miss Judy A. Causby
North Carolina School for the Deaf--Hoey Hall
Highway 64, South
Morganton, North Carolina 28655

Mr. Robert Cichowski, Coordinator
Classes for the Hearing Impaired
Douglas Elementary School
6400 Hartel
Garden City, Michigan 48135

Mrs. Marjorie Clere
145 Roney Road
Syracuse, New York 13205

Ms. Billie Collier
Kansas School for the Deaf
450 East Park Street
Olathe, Kansas 66021

Mrs. Elaine Costello
Project for Individualizing Instruction
for the Deaf
Callier Hearing and Speech Center
1966 Inwood Road
Dallas, Texas 75235

Ms. Romona Crookham
624 Lindberg Drive
Council Bluffs, Iowa 51501

Mr. Paul Cunningham
Model Secondary School for the Deaf
7th and Florida Avenues, N.E.
Washington, D. C. 20002

Jon Curtis
Southwest Regional Media Center for the Deaf
P. O. Box 3AW
University Park Branch
Las Cruces, New Mexico 88001

Mrs. Weslee D'Audney
Department of Special Education
University of Nebraska at Omaha
Omaha, Nebraska 68132

Mr. Robert Davila
Center for Instructional Communications
Syracuse University
Syracuse, New York 13210

Mr. Richard O. Davis
Principal of Advanced and Intermediate
Missouri School for the Deaf
5th and Vine Streets
Fulton, Missouri 65251

Sister Mary Delaney
Curriculum Director
St. Mary's School for the Deaf
2253 Main Street
Buffalo, New York 14214

Dr. Gilbert L. Delgado, Chief
Media Services and Captioned Films
DHEW/OE/BEH/DES
7th and D Streets, S.W., Room 2022
Washington, D. C. 20202

Mr. Norman Devine
Upper Elementary Principal
Iowa School for the Deaf
Highway 375
Council Bluffs, Iowa 51501

Dr. Leo Dicker, Director
Program for the Education of the Deaf
University of Wisconsin-Milwaukee
3253 North Downer Avenue
Vogel Hall, Room 203
Milwaukee, Wisconsin 53211

Mr. John Dostal
Project LIFE
1201 16th Street, N.W.
Washington, D. C. 20036

Mr. James E. Doyle
Wilson School, Deaf Day Classes
2002 North Clark Street
Davenport, Iowa 52804

Mrs. Sue K. Drake
Texas School for the Deaf, East Campus
1102 South Congress
Austin, Texas 78703

Mr. Robert Edwards
Southwest Regional Media Center for the Deaf
P. O. Box 3AW
University Park Branch
Las Cruces, New Mexico 88001

Dr. Donald K. Erickson, Director
CEC Information Center on Exceptional Children
1411 South Jefferson Davis Highway, Suite 900
Arlington, Virginia 22202

Miss Bonnie Everhart, Supervisor
Programs for Hearing Impaired Children
940 South Lee Street
Des Plaines, Illinois 60016

Mr. Richard Fetrow, Director
Media Center
Iowa School for the Deaf
Council Bluffs, Iowa

Miss Arlene Finkelstein
National Technical Institute for the Deaf
Rochester Institute of Technology
1 Lomb Memorial Drive
Rochester, New York 14623

Dr. David C. Fischer
Nebraska State Department of Health and Education
814 Lincoln Building
Lincoln, Nebraska 68508

Sister Mary Frances Fitzgerald
Assistant Professor of Art
Fontbonne College
Wydown and Big Bend Boulevards
St. Louis, Missouri 63105

Miss Nancy E. Fogel
Asst. Professor of Special Education
Augustana College
P. O. Box 869
Sioux Falls, South Dakota 57102

Mrs. Helen Freeman, Supervisor
Instructional Materials Center
Louisiana State School for the Deaf
P. O. Box 3074
Baton Rouge, Louisiana 70821

Mrs. Rhoda Freeman
Marlton School for the Deaf
4000 Santo Tomas Drive
Los Angeles, California 91602

Mrs. Jamesine E. Friend
Stanford University
Stanford, California

Mr. Louis W. Frillmann
Educational Director
Lexington School for the Deaf
26-26 75th Street, Jackson Heights
New York, New York 11370

Mr. Harry Funk
University of Kansas
Hearing and Speech Department CRU
University of Kansas Medical Center
Olathe Boulevard
Kansas City, Kansas 66103

Mrs. Waunita Garner
Project LIFE
1201 16th Street, N.W.
Washington, D. C. 20036

Mrs. Ruth Geier
Head Teacher, Primary Department
Central Institute for the Deaf
818 South Euclid
St. Louis, Missouri 63110

Mr. Randall Genrich
Educational Media Resource Teacher
Emerson School
1421 Spruce Place
Minneapolis, Minnesota 55403

Dr. C. Joseph Giangreco, Superintendent
Iowa School for the Deaf
Highway 375
Council Bluffs, Iowa 51501

Dr. David P. Goldstein
Purdue University
Audiology and Speech Sciences
Heavilon Hall
West Lafayette, Indiana 47907

Mrs. Harriet Gough
Pittwillow, Route 2
Nottingham, Pennsylvania 19362

Dr. John A. Gough
Pittwillow, Route 2
Nottingham, Pennsylvania 19362

Mr. Gary Gray
Educational Service Unit #4
Auburn, Nebraska

Ms. Carol Griffin
4202 N. Kentucky
Oklahoma City, Oklahoma

Mr. Wayne A. Gustafson
AV Coordinator
Lincoln Elementary School
2427 West 4th Street
Duluth, Minnesota 55806

Miss Terry Hammond
Carlson School
Rockford Public Schools
Rockford, Illinois 61108

Mr. E. Kenneth Hanks, Jr.
Kansas School for the Deaf
450 East Park Street
Olathe, Kansas 66061

Mr. Britt M. Hargraves, Director
Teacher Preparation Program in Deafness
Western Maryland College
Education Department
Westminister, Maryland 21157

Mrs. Jane Gilchrist Harris
Dallas County-Wide Day School for the Deaf
3700 Ross Avenue
Dallas, Texas 75204

Mr. Allen J. Hayek, Superintendent
North Dakota School for the Deaf
Devils Lake, North Dakota 58301

Mr. Harry G. Hayler
Special Education Department
University of Nebraska at Omaha
Omaha, Nebraska 68132

Dr. Marshall Hester
Route #2
Las Cruces, New Mexico 88001

Mr. Bruce Hicks
3030 Cass
Omaha, Nebraska

Sister James Lorene Hogan
Director of Deaf Education
Fontbonne College
Wydown and Big Bend Boulevards
St. Louis, Missouri 63105

Ms. Jane Hollar
National Technical Institute for the Deaf
Rochester Institute of Technology
1 Lomb Memorial Drive
Rochester, New York 14623

Dr. Herman Holste, Principal
Lutheran School for the Deaf
6861 East Nevada
Detroit, Michigan 48234

Mrs. Fern Ihfe
2127 Harwood
Lincoln, Nebraska

Dr. William D. Jackson, Director
Southern Regional Media Center for the Deaf
University of Tennessee
1812 Lake Street
Knoxville, Tennessee 37916

Miss Karen M. Jensen
Supervisor, Education of the Deaf
Communicative Disorders
Fresno State College
Fresno, California 93726

Miss Barbara Johnson
Asst. Coordinator of Hearing
Northwestern Illinois Association
311 North 4th
DeKalb, Illinois 60115

Mr. J. James Kearney
Model Secondary School for the Deaf
Gallaudet College
7th and Florida Avenues, N.E.
Washington, D. C. 20002

Miss Eloise Kennedy
New Mexico School for the Deaf
1060 Cerrillos Road
Santa Fe, New Mexico 87501

Mr. Dermot Keohane
The Learning Center for Deaf Children
P. O. Box 2046
Framingham Center, Massachusetts 01701

Ms. Martha Killian
Kansas School for the Deaf
450 East Park Street
Olathe, Kansas 66021

Mrs. Rose C. King, Principal
Deaf Department
Virginia School at Hampton
700 Shell Road
Hampton, Virginia 23361

Mr. James Kirkley, Principal
Department for the Deaf
Colorado School for the Deaf and Blind
Kiowa and Institute Streets
Colorado Springs, Colorado 80903

Mrs. Cheryl Kling
Southwest Regional Media Center for the Deaf
Las Cruces, New Mexico 88001

Mr. Don Kurth
Polk County Board of Education
112-11th Street
Des Moines, Iowa 50322

Mr. Melvin Ladson, Jr.
State Supervisor of Deaf Children
Massachusetts State Bureau of Special Education
182 Tremont Street
Boston, Massachusetts 02111

Mr. Roderick Laird
Wyoming School for the Deaf
539 South Payne Avenue
Casper, Wyoming 82601

Mr. Leonard Lane
Project LIFE
1201 16th Street, N.W.
Washington, D. C. 20036

Mr. Kendall Litchfield, Principal
New York School for the Deaf
555 Knollwood Road
White Plains, New York 10603

Dr. Edgar L. Lowell, Administrator
John Tracy Clinic
806 West Adams Boulevard
Los Angeles, California 90007

Mr. James Mangan
Southwest Regional Media Center for the Deaf
P. O. Box 3AW
University Park Branch
Las Cruces, New Mexico 88001

Mrs. Jacqueline Manning
Branch County Intermediate
200 Bishop
Coldwater, Michigan 49036

Mrs. Denna Massey
Special Education
University of Nebraska at Omaha
Omaha, Nebraska 68132

Mrs. Mary Carolyn Maves
Task Force on Religious Education and
Deaf Persons
National Council of Churches
9607 Hardy Drive
Overland Park, Kansas 66212

Mr. James E. McCarr
Oregon State School for the Deaf
999 Locust Street, N.E.
Salem, Oregon 97310

Mrs. James (Dorothy) McCarr, Principal
Oregon State School for the Deaf
999 Locust Street, N.E.
Salem, Oregon 97310

Sister Mary Kieran McCormack
The Boston School for the Deaf
800 North Main Street
Randolph, Massachusetts 02368

Mrs. Barbara McCulloch
Lincoln Public Schools/University of Nebraska
720 South 22nd
Lincoln, Nebraska 68504

Mrs. Thelma McDonald
Dept. of Special Education
University of Nebraska at Omaha
Omaha, Nebraska 68132

Miss Kathleen McKenney
Dept. of Special Education
University of Nebraska at Omaha
Omaha, Nebraska 68132

Mr. John F. McLaughlin, Jr.
Northeast Regional Media Center for the Deaf
Thompson Hall
University of Massachusetts
Amherst, Massachusetts 01002

Mr. Reid C. Miller
University of Utah
Bldg. HPRW-121
Salt Lake City, Utah 84112

Mrs. Janet Miracle
Kansas School for the Deaf
Park Street
Olathe, Kansas 66061

Mr. Arthur Montoya
Southern Regional Media Center for the Deaf
University of Tennessee
Knoxville, Tennessee

Miss Lucy M. Moore
Trenton State College
Trenton, New Jersey

Miss Mary Mullane
Rockford Public School System
913 N. Main Street
Rockford, Illinois 61108

Dr. Harry Murphy
Southwest School for the Deaf
4110 W. 154th Street
Box 671
Lawndale, California 90260

A. S. Myklebust, Supt.
South Dakota School for the Deaf
1800 E. 10th St.
Sioux Falls, South Dakota

Robert F. Newby
Pennsylvania School for the Deaf
7500 Germantown Ave.
Philadelphia, Pennsylvania 19119

Gary W. Nix
Hosford Center for the Deaf
2303 S.E. 28th Place
Portland, Oregon 97214

Malcolm Norwood
Education Officer, Acquisition
HEW-USOE
Media Services & Captioned Films
Washington, D. C. 20202

Ms Anita Nourse
Northeast Regional Media Center for the Deaf
Thompson Hall
University of Massachusetts
Amherst, Massachusetts 01002

Miss LeAnn Olson
Administrator
Omaha Hearing School
4410 Dewey Avenue
Omaha, Nebraska 68105

Mrs. Jane L. Omer
Education Center
1005 Pitt
Olathe, Kansas

Mrs. Virginia Opocensky
2640 S. 35th
Lincoln, Nebraska 68506

Terrence J. O'Rourke
National Association of the Deaf
905 Bonifant Street
Silver Spring, Maryland 20910

Vincent Palacino, Jr.
Michigan State University
1435D Spartan Village
E. Lansing, Michigan 48823

Mr. L. R. Parke
Kansas School for the Deaf
450 E. Parks
Olathe, Kansas 66061

Stanley A. Patrie
Northeast Regional Media Center for the Deaf
Thompson Hall
University of Massachusetts
Amherst, Massachusetts

Roger S. Perkins
Southern Regional Media Center for the Deaf
University of Tennessee
Knoxville, Tennessee

John E. Persinger
Margaret S. Sterck School for Hearing Impaired
Chestnut Hill Rd & Cherokee Drive
Newark, Delaware

Dr. Leo E. Persselin
Dubnoff School for Educational Therapy
10526 Victory Place
North Hollywood, California 91606

Jean Petta
California State College Los Angeles
5151 - State College Drive
Los Angeles, California 90032

Dr. Glenn Pfau, Director
Project LIFE
National Education Assoc.
1201 16th St., N.W.
Washington, D. C.

Joseph R. Piccolino
St. Mary's School for the Deaf
2253 Main St.
Buffalo, New York 14214

Peter Pipe
1060 Estrellita Way
Los Altos, California 94022

Mrs. Patricia Posey
Project LIFE
National Education Assoc.
1201 16th St., N.W.
Washington, D. C.

Mrs. Linda Prokes
Intermediate Department
Florida School for the Deaf & Blind
San Marco Avenue
St. Augustine, Florida 32084

Rev. Quintin F. Quade
Word of God Lutheran Church for the Deaf
2308 D Avenue N.E.
Cedar Rapida, Iowa 52402

Dr. Howard M. Quigley
Educational Media Distribution Center
5034 Wisconsin Avenue, N.W.
Washington, D. C. 20016

Leonora Quill
Champaign Community Schools
703 S. New
Champaign, Illinois 61820

Mr. Frederick Ralston
Project LIFE
National Educ. Assoc.
1201 16th St., N.W.
Washington, D. C.

Darrel Randall
Kansas School for the Deaf
Olathe, Kansas 66061

William Ransdell
Lake-McHenry Region
4440 Grand Ave.
Gurnee, Illinois 60031

Miss Eliza Jane Ray
Project LIFE
National Education Assoc.
1201 16th St., N.W.
Washington, D. C.

Mr. & Mrs. John Reed
2701 South 12th
Lincoln, Nebraska 68502

Patrick Reilly
Project LIFE
National Education Assoc.
1201 16th St., N.W.
Washington, D. C.

Mrs. Blanche Reuck
Illinois School for the Deaf
125 Webster St.
Jacksonville, Illinois 62650

Kenneth Rislov
Northwestern Illinois Assoc.
311 North Fourth Street
DeKalb, Illinois 60115

Ramon Rodriguez
Southwest Regional Media Center for the Deaf
Box 3AW
Univeristy of New Mexico
Las Cruces, New Mexico 88001

Mrs. Linda C. Rose
Dept. of Spec. Ed.
University of Nebraska at Omaha
Omaha, Nebraska

Dr. Stanley D. Roth
Kansas School for the Deaf
450 E. Park St.
Olathe, Kansas 66061

Martin Rothman
Shderot Haneseim 234/6
Shikun Daled
Beer-Sheva, Israel

Gloria Rothman
Beer-Sheva, Israel

Mrs. Nancy Rushmer
Teacher Training - Lewis & Clark College
2936 N. W. Savier
Portland, Oregon 97210

Barrie Schwartz
Northeast Regional Media Center for the Deaf
Thompson Hall
University of Massachusetts
Amherst, Massachusetts

Miss Louise L. Scott
Project LIFE
National Education Assoc.
1201 16th St., N.W.
Washington, D. C.

Thomas S. Serwatka
Lakewood Oral School
1215 W. Clifton
Lakewood, Ohio 44107

Helen Ross Sewell
Texas School for the Deaf
1102 South Congress Avenue
Austin, Texas 78704

Joyce Sheehy
Lakeview Public Schools
25901 Jefferson
St. Claire Shores, Michigan 48081

Margaret G. Snyder
Michigan School for the Deaf
W. Court St. at Miller Rd.
Flint, Michigan 48504

Sister Francis Solano
St. Francis de Sales School for the Deaf
697 Carroll St.
Brooklyn, New York

Dr. David Spidal
Project LIFE
National Educ. Assoc.
1201 16th St., N.W.
Washington, D. C.

Virginia Steele
3900 N. 12th
Lincoln, Nebraska 68521

Mr. Robert Stern
Spec. Ed. Dept.
University of Nebraska at Omaha
Omaha, Nebraska

Patrick S. Stone
Tucker-Maxon Oral School
2860 South East Holgate
Portland, Oregon 97202

Mrs. Pamela Stoudt
Kansas School for the Deaf
450 East Park Street
Olathe, Kansas

Mrs. June Stuart
Kent Public Schools
Kent, Ohio 44240

Mr. Alan K. Summers
Marie H. Katzenbach School for the Deaf
Sullivan Way
West Trenton, New Jersey 08625

Hubert D. Summers, Director
Southwest Regional Media Center for the Deaf
Box 3AW
Las Cruces, New Mexico 88001

Dr. Patrick Suppes
Stanford University
Ventura Hall
Stanford, California 94305

Miss Vivian Tasker
Dept. of Spec. Educ. , Fairchild Hall
Illinois State University
Normal, Illinois 61761

Hal Tately
General Electric Co.
Bldg. 5 Room 343, 1 River Road
Schenectady, New York 12301

Susan Teas
Okla Univ. Medical Center
School for the Deaf
Norman, Oklahoma

Joan Tellam
Arizona School for the Deaf
1017 Blacklidge
Tucson, Arizona 85719

William Tellam
Tucson, Arizona 85719

Sivasailam Thiagarajan
Indiana University
Bloomington, Indiana

George H. Thompson
Nebraska School for the Deaf
3223 N. 45th St.
Omaha, Nebraska 68104

Chaplain and Mrs. I.M. Thvedt
Minnesota School for the Deaf
15 NE 6 Ave.
Faribault, Minnesota 55021

Susie Titus
Southwest Regional Media Center for the Deaf
Box 3 AW
Las Cruces, New Mexico 88001

Dr. Donald V. Torr
Gaullaudet College
Kendall Green
Washington, D. C. 20002

Mrs. Donald Torr
Washington, D. C.

Miss Elaine Trukken
Minnesota School for the Deaf
23 S. E. 6th Ave.
Faribault, Minnesota 55021

Mr. Robert Van Dyke
18216 Harwood Avenue
Homewood, Illinois 60430

Mrs. Helen Walcher
University of Oklahoma Medical Center
School for the Deaf
2525 N.W. 28
Oklahoma City, Oklahoma 73107

Starla C. Warburton
John Tracy Clinic
806 West Adams Blvd.
Los Angeles, California 90007

Lee L. Waters, Director
West Suburban Assoc. for the Hearing Handicapped
141 Green Valley Drive
Lombard, Illinois 60148

Lucie E. Weeks
Sterck School
Chestnut Hill Road & Cherokee Drive
Newark, Delaware 19711

Mrs. Esther Westendorf
Black Hawk-Buchanan Co.
501 Jefferson
Waterloo, Iowa 50703

Mr. David White
Dept. of Spec. Ed.
University of Nebraska at Omaha
Omaha, Nebraska

Dr. John Wiley
Speech Clinic
University of Michigan
Ann Arbor, Michigan

Robert C. Wills
Kansas School for the Deaf
450 E Parks
Olathe, Kansas 66061

G. I. Wilson
Oregon State School for the Deaf
999 Locust N.E.
Salem, Oregon 97303

Dr. Frank Withrow, Director
Division of Educational Services
BEH-USOE
Washington, D. C. 20202

Tomiko I. Yamashita
Hawaii School for the Deaf & Blind
3440 Leahi Ave.
Honolulu, Hawaii 96815

Sister Virginia Young
St. Mary's School for the Deaf
2253 Main St.
Buffalo, New York 14214

Joseph P. Youngs, Jr.
Gov. Baxter State School for the Deaf
Box 799
Portland, Maine 04104

Mr. Charles Zerrip
Project LIFE
National Education Assoc.
1201 16th St., N.W.
Washington, D. C.

George Zook
Illinois School for the Deaf
Jacksonville, Illinois